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COVER PHOTO

Test pilots at Eglin Air Force Base made a flight testing the effect of napalm flames on a jet engine. During this low-level demonstration strike, Capt. William C. Sharp, jet fighter specialist, put this F-84 Thunderjet through the flaming wake of a napalm bomb with narrow escape. The engine failed for lack of air but he managed to restart it and landed safely.

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ANNUAL MEETING SPEAKERS

THE BANQUET

General Curtis E. LeMay, Commanding General of the Strategic Air Command with headquarters at Offutt Air Force Base, Omaha, Nebraska, will be the guest speaker of the Armed Forces Chemical Association at the annual banquet, May 21. General LeMay's far-flung command includes not only the strategic air units in this country but also those of the U. S. Air Force in the Far East and Europe. During the war General LeMay commanded the Third Bombardment Division, Eighth Air Force in Europe and led the famous shuttle mission of Flying Fortresses from England to Africa (Target: Regensburg, Germany). Later he took command of B-29s in the Far East in the operations against Japan.

GEN. CURTIS E. LEMAY

THE SYMPOSIUM*

THE HON. VAL PETERSON

The Honorable Val Peterson, Director of the Civil Defense Administration, is a former Governor of Nebraska, having served three terms in that office from 1947 to 1953. Governor Peterson is a graduate of Wayne State Teachers College, Nebraska, and has a Master's Degree in Political Science from the University of Nebraska. He is a Colonel in the Air Force Reserve, having served in the Air Force in the Burma-India Theatre during World War II.

MAJ. GEN. M. R. NELSON, USAF

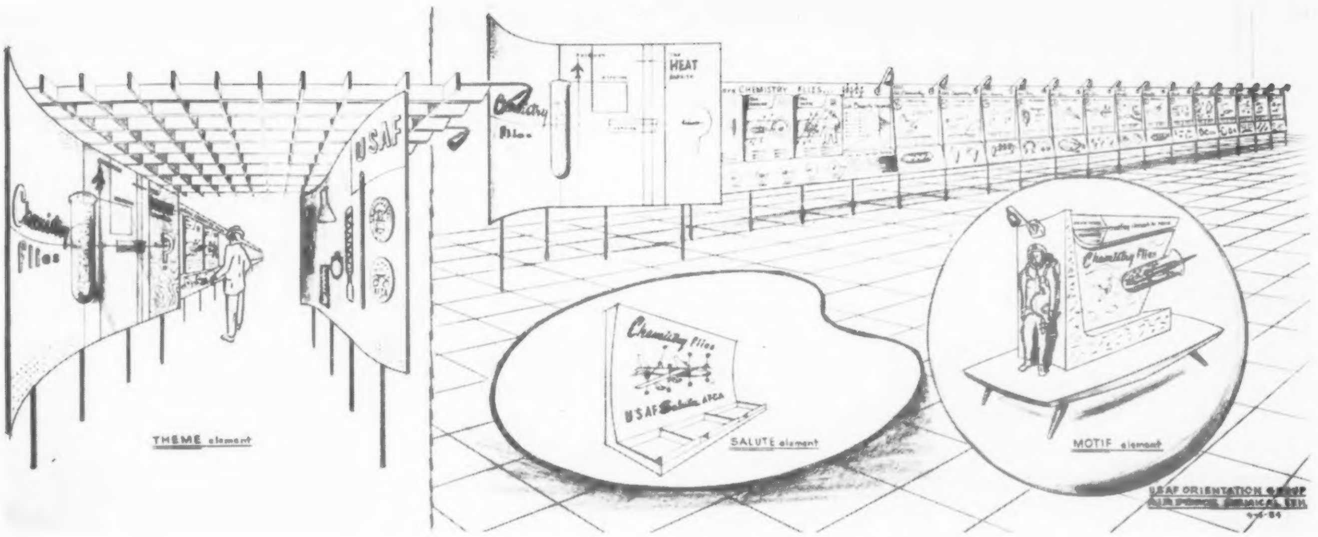
General Nelson is Commanding General of the Eastern Air Defense Force, with headquarters at Stewart Air Force Base, Newburgh, New York. He was graduated from the United States Military Academy in 1926 and commissioned in the Air Service upon graduation. During the war he served in the Mediterranean Theatre. Among his duty assignments at Air Force headquarters, in Washington, D. C., were those of Chief of the Special Weapons Group and Assistant to the Asst. Deputy Chief of Staff, Operations, for Atomic Energy.

REAR ADM. W. G. SCHINDLER, USN

Admiral Schindler is Assistant Chief of Naval Operations. He graduated from the United States Naval Academy in 1917.

As a Gunnery Officer during the early part of World War II he was awarded the Navy Cross for extraordinary heroism and courageous devotion to duty while acting as gunner in an airplane in operations against the Japanese forces at Tulagi, and in the Coral Sea. Later during the war he had command of the USS Topeka in the Pacific. Among his subsequent assignments were command of the Naval Ordnance Laboratory, White Oak, Md., and Commander of Cruiser Division THREE, until assuming his present duties.

*The Army speaker is to be the Chief Chemical Officer.



ROUND-UP PRE-VIEW OF 9th ANNUAL MEETING

THE SHOREHAM, WASHINGTON, D.C. MAY 20-21

The U. S. Air Force in role of host; theme of meeting "Chemistry Flies."

The U. S. Air Force is going "all out" to help make this gathering an outstanding success. Participating extensively in all phases of the two-day program, the Air Force has given new meaning to the term "host service." Indicative of its recognition of the role of chemical science and industry in National Defense is the elaborate Air Force exhibit specially fabricated for this meeting (photo of artist's painting shown above).

Registration and information desk—main lobby, opposite hotel desk.

Advance banquet plate-reservations by A.F.C.A. group member companies, already well over 200, together with individual reservations on pre-registration forms received at the time of this writing, give promise of a large, possibly a record, attendance at this meeting.

The registration desk will be open during the evening of May 19 as well as all day on May 20 and 21. Whether or not pre-registration forms have been sent in, members and their guests are urged to register at the A.F.C.A. desk at the hotel as soon as possible after arrival. Name badges to be issued on registration are required for meetings.

Briefing at the Pentagon, Thursday, May 20, transportation leaves Shoreham 9:45 a.m.

This is open to all registered members and their guests including ladies. It will consist of a statement of the military situation at the time as viewed by the Air Force. As now planned this session will be held in the Pentagon Auditorium on the 5th floor. It is desired that all attending this meeting go together as a group. The Air Force will provide guides. The use of transportation other than that specially provided is therefore not practicable. Buses will leave the Shoreham promptly at 9:45 a. m. so that all may be seated for opening of the Pentagon meeting at 10:30. All attending should wear their name badges.

Andrews Air Base—luncheon and afternoon program May 20.

Following the briefing at the Pentagon which will be completed by 11:30 a. m., members and guests will proceed by special transportation to Andrews Air Force Base, a short distance from Washington. A buffet luncheon will be served at the Officers Club. Tickets for the luncheon, $1.50 each, should be obtained at the registration desk before leaving the Shoreham for the briefing at the Pentagon. After luncheon an interesting program including static and other exhibits has been arranged. This will take up the afternoon. It is expected that buses will leave Andrews so as to return the visitors to the Shoreham by 4:30 p. m.

The evening of May 20 is open for viewing of exhibits, company parties and individual plans of members.

Exhibits — Defense agencies and industry — at hotel May 20 and 21.

On registering, members and guests will be given a copy of the souvenir program to be issued for the meeting. It will include information of the various exhibits at this

meeting, all of which will pertain to the National Defense. In general these exhibits will be located as follows:

AIR FORCE—Bird Cage Walk

ARMY CHEMICAL CORPS—Terrace Foyer

ATOMIC ENERGY COMMISSION, A.F.C.A., and some industrial displays—West Foyer

CIVIL DEFENSE—Mezzanine

Directors' meeting—A.F.C.A. Hqrs. Suite, 8:00 p.m., May 20.

This is the principal business session of the Directors group which consists of the twenty Directors-at-Large, the national officers of the Association and the Chapter Presidents or their designated representatives.

In addition to consideration of plans and policies for the forthcoming year, the annual election of officers will be held at this meeting. This year a new president will be elected in conformity with provisions of the Constitution limiting tenure of that office to two terms.

General meeting 10:00 a.m., May 21, main ballroom—for all registered members.

At this session for the general membership, the newly elected officers will be announced and introduced. There are several important awards to be made at this time including the annual A.F.C.A. Safety Award to the Chemical Corps Installation which has the best safety progress record for the year. Time permitting this session will also be used for expression of views by members generally.

Symposium on "Disaster Planning," 2:00 p.m., May 21, main ballroom.

This broad subject bears directly upon Government, industry and individual citizens. In deciding upon it, the Program Committee took note that it is not so dismal as the name may indicate, that the program involved has positive, constructive aspects which it is not really fair to brand with the label "Prepare for the Worst." A better term, it is felt, might be "Prepare to Avoid the Worst."

The topic includes not only war hazards but also those disasters which may result from accidents or from natural causes.

The Department of Commerce has prepared a report on the subject including a suggested protective organization for industry, the booklet entitled "Emergency and Disaster Planning," is now on public sale by the Superintendent of Documents, Government Printing Office, Price 25c.

In a separate article herein Dr. Dill of the Army Chemical Center tells of scientific studies in progress as to psychological and social behavior aspects of disasters. From such studies it is presumed better protective procedures may result.

For the symposium it is planned that the Chief Chemical Officer of the Army will open the series of talks, calling attention to the nature of the various possible hazards involved, particularly those pertaining to toxic means of warfare.

Major General Morris R. Nelson, Commanding General, Eastern Air Defense Force, is scheduled to follow with a presentation of the dangers from the air and, in so far as they may be stated, the Air Force means and measures for dealing with them.

Rear Admiral W. G. Schindler, Asst. Chief of Naval Operations, is listed to follow General Nelson, developing the subject from the viewpoint of Naval considerations.

Rounding out these talks from the Armed Forces agencies will be the discussion by The Hon. Val Peterson, Federal Civil Defense Administrator.

It had been planned, and was so announced, that the program would include a presentation from the chemical industry. However it was since found impractical to have the particular presentation which had been planned. The elimination of this feature, will allow some time for questions and discussion from the floor and for comments by the Chair. President Munchmeyer will preside at this meeting.

Reception and cocktail party—6:00 p.m., May 21, west ballroom.

Dress for this event and the banquet to follow is optional—either dinner jacket or business suit being suitable. However, as the banquet will start at 7:30 there will not be time to change so it is suggested that members wear the same attire at the reception that they are to wear at the banquet.

The banquet—7:30 p.m., May 21, Terrace Dining Room, General LeMay the guest speaker.

The guest speaker, General Curtis E. LeMay, Commanding General of the Strategic Air Command, is a national figure who needs no introduction here. His dynamic personality and his reputation as a forceful and interesting speaker assure the success of this highly important event of the program.

In addition to providing the guest speaker the Air Force participation at the banquet will include music by the Air Force Ceremonial Band of some 35 pieces. There will be a march-in by a Color Guard, singing of the National Anthem and invocation and benediction by military Chaplains.

Ladies program — visits to White House and foreign embassies—May 21.

Ladies whose names and addresses have been sent in to A.F.C.A. for listing for the White House visit will proceed there by chartered bus, leaving the Shoreham, at 8:15 a. m. It is expected that the tour of the rooms to be shown including the China room will take about one hour. To each lady making this visit the A.F.C.A., is presenting a photograph of an autographed picture of Mrs. Eisenhower and a special identification card. Following the tour of the White House there will be visits to several foreign embassies, at least two and possibly three. It had been arranged with one of the embassies to provide luncheon but unforeseen circumstances have since arisen which have necessitated change in the scheduled visits. This resulted in elimination of the luncheon feature. The sub-committee in charge of this phase of the program has an attractive alternate plan which will include tea at one of the embassies to be visited in the afternoon.

Quarters

It is learned that a limited number of BOQ spaces are available at Ft. McNair and Ft. Meyer for regular and reserve officers who are attending the meeting. It is not necessary that reserve officers be on active duty in order to occupy such quarters. There are no quarters available for families.

BANQUET RESERVATIONS OF COMPANIES

Reservations for the banquet have been received from the following Companies:

United-Carr Fastener Corp., Rohm & Haas Company, Buffalo Electrochemical Co., Inc., International Salt Co., Casco Products Corp., The H. K. Ferguson Co., Niagara Alkali Co., Koppers Company, Inc., Armour & Company, Hercules Powder Company, Bridgeport Brass Company, Carbide & Carbon Chemicals Co., Blaw-Knox Company, Chemical Plants Div., Zenith Plastics Co., Philco Corporation, Walter Haertel Co., Allied Chemical & Dye Corp., General Aniline & Film Corp., Goodyear Tire & Rubber, Arthur D. Little, Inc., American Cyanamid Co., Ferro Corporation, Monsanto Chemical Co., General Tire & Rubber Co., Firestone Tire & Rubber Co., L. E. Mason Co., Federal Laboratories, Inc., Atlas Powder Company, Cinch Manufacturing Corporation, Charles Pfizer & Co., Bayshore Industries, The Ralph M. Parsons Co., American Hydrotherm Corporation.

A MESSAGE FROM OUR AFCA PRESIDENT

Annual Meeting

The key to our Annual Meeting—"Chemistry Flies"—is most intriguing as we look into chemistry's relationship with the Air Force. We find that the chemical industry plays a vital role in nearly all the materials that the Air Force uses; thus, a very large part of the new military concept, stressing air power, revolves around chemistry.

The exhibits, including those by the plastics and Atomic Energy groups, that will be shown at the Annual Meeting will demonstrate visually this close relationship of the chemical industry to the Air Force program.

Our Disaster Planning Symposium will cover many points that I am sure will be of vital interest to you as a representative of your community and as a representative of your company. We have many things confronting us as we face up to these new special weapons, and I am sure you will get some worthwhile ideas from this symposium to take back to your own company and community for their planning against disaster.

L. W. MUNCHMEYER

ARMED FORCES DAY

Throughout the nation, posts, camps and stations of the Armed Forces will be "at home" to the public on May 15, which has been designated by the President as Armed Forces Day. The only exceptions will be those installations where such programs would not be feasible or desirable because of security or other factors.

A booklet issued by the Department of Defense indicates the extensive scope of exhibits, military displays and other programs which will be presented in celebration of this day, the slogan for which this year is, "Power for Peace." The booklet quotes President Eisenhower's message on the State of the Union, wherein he said:

"Since our hope for all the world is peace, we owe ourselves and the world a candid explanation of the military measures we are taking to make that peace secure."

NERVE GAS

The Army Chemical Corps in a fact sheet of information in regard to Nerve Gas recently prepared makes this statement in evaluation of this war agent:

"The recent development of new and highly toxic chemical warfare agents such as the nerve gases, whose presence is not ordinarily detectable by the senses, together with the tremendous advances in speed, load capacity and range of modern military aircraft, make chemical warfare against the civilian population of the United States a distinct possibility either in the form of an accessory to high explosive bombing, or alone in a surprise attack . . . "

It is also of interest to note that the Chemical Corps confirms recently published reports to the effect that nerve gas is being manufactured at the Chemical Corps Rocky Mt. Arsenal at Denver, Colorado.

GEN. CREASY NOMINATED

As the JOURNAL went to press news was received of the nomination by the President of Brigadier General William M. Creasy, commanding the Army Chemical Center, Md., to be Chief Chemical Officer of the Army with rank of major general to succeed Major General Bullene who recently retired.

HEADQUARTERS
12th ROK DIVISION

8 November 1953

SUBJECT: Letter of appreciation

TO: 2nd Platoon, 388 U.S. Smoke Generator Co.

1. It is my great pleasure to express my appreciation for your exceptionally meritorious performance of duty since you were placed as the smoke support unit for this Division. You have overcame many obstacles and difficulties and by your efforts have contributed much in our fight against a common enemy of both of our peoples.

2. The excellent smoke support furnished by your unit did much to blind the enemy from observing our main supply route and military installations. Your support was exceptionally effective during the period 16 to 18 July 1953 when this Division was heavily attacked by the enemy.

3. Your cooperation with our unit is a worth while example for all armies to follow and well illustrates the spirit of mutual cooperation between the United Nations and the Republic of Korea fighting forces.

4. I, therefore, award you this Letter of appreciation to express my gratitude for a job well done.

YOUN CHUG KEUN
Brigadier General
Commanding

감 사 장

미 제三八八중대 제二소대

제十二사단
사단장 준장 윤 춘 근

The unique document pictured above from a photograph recently received from Korea will no doubt find an honored place in the battle records and archives of the Army Chemical Corps.

In both English and Korean it expresses the appreciation of the Commander of the 12th ROK Division for the support rendered the Division by a Chemical Corps smoke generator platoon.

This platoon is the 2nd Platoon of the 388th Chemical Smoke Generator Company. The Company was cited for exceptionally meritorious conduct for smoke operations in support of three United States Corps, by the Eighth U. S. Army.

(The citation was printed in the Oct. 1953 issue of the Journal.)

CHEMICAL INDUSTRY AND

By **General Charles L. Bolte**
Vice Chief of Staff, U. S. Army

Modern military power is underwritten by chemical science and industry. Thus, leadership in applied chemistry paves the way to unassailable military strength. During the four decades that have elapsed since the beginning of the first World War, the United States has attained primacy in the chemical field and, with it, an arms system of commanding influence. This is something more than mere coincidence.

When I entered the Army in the spring of 1917, chemistry represented a secondary but promising industry in our national economy. And certainly our armed forces were not regarded seriously by the nations then at war. Things being as they were at the time, my degree in chemical engineering from the old Armour Institute in Chicago (now Illinois Institute of Technology) suddenly seemed less important than my commission as an Infantry Reserve Officer. Once in the Army, I never returned to industry. Yet my early training in the chemical field has given me one unique advantage.

As an embryo chemical engineer I was able to appreciate more than most of my contemporaries in the service, the interrelationship between the growth of our national chemical industry and our remarkable development of military power. Neither, I should say, would have been possible without the other. Taken together, they constitute today the strong buttress of our capability to preserve the sovereignty of the free world.

In looking back, it is difficult to say which of these impressive developments is the more significant—our rise, well within one man's working years, from a minor to a commanding position as a chemical-industrial nation, or our advance from a secondary military status to the position of unquestioned strength which we occupy in the present critical period in world affairs. The two are clearly complementary factors in the evolution of our national destiny.

There are two broad aspects to the utilization of chemistry in national defense. One is the applying of chemical action directly in combat; or, what we call chemical warfare. The other is the employment of chemical processes and chemical compounds in support of the entire munitions program. Obviously the products of chemical industry are infinitely more important as components of military end items than they are as direct military agents. In fact chemical warfare is a mere by-product of chemical industry, the principal harvests of which are fed into everything the fighting man uses, from tetranitrates to penicillin. All phases of modern technology must be drawn upon to keep our military, naval, and air armaments ahead of competition, yet today war is fought from a chemical base while the key to almost every new development is to be found in chemical science.

The field of metallurgy alone clearly illustrates the impact of newly-developed chemicals and chemical processes on industrial production, particularly in heavy industry. Without the applications of chemistry to manufacturing techniques, production of steel with present-day qualities would be impossible. The contribution of chemistry to the preparation of special alloy steels for jet engines is well known; without this contribution, these engines could not withstand the heat and pressures generated, and modern-day supersonic flight would not be possible. In addition, newer, more efficient chemical processes have played a significant part in the production of nearly one million tons of copper annually. Magnesium, also, one of the light metals so important in the aircraft industry and more lately in ground weapons, is principally derived by chemical extraction from sea water. And finally, titanium, the newest of the light metals to be successfully refined, and the ninth most abundant element in the earth's crust, is available for our use only through the science of chemical extraction.

On the Eve of World War I

Looking back to the situation that existed in 1912, when I first took up the study of chemical engineering, certainly the position of the United States was weak. Germany in those days had an unquestioned monopoly of the processes by which chemical molecules are blended into the synthetics that were needed in almost every type of industry. Germany also claimed a monopoly on chemical brains, a claim that I do not recall was then very seriously disputed on this side of the Atlantic. If the rulers of Germany had had the wisdom to continue the conquest of world trade through an established dominance of industrial chemistry, instead of by arms, the history of the twentieth century might have been altogether different.

It was mastery of the techniques of transmitting coal tars into hydrocarbons that provided the basis for German leadership in industrial chemistry in the years just preceding the first World War. This affected everyone who used such common necessities as dyes and medicinals. Through a cartel of six large coal-tar companies Germany was able to dominate world trade in intermediate chemicals which went into a wide range of end products including, of course, high explosives.

It is not too much to say that, when German forces crossed the Belgian frontier on 4 August 1914, United States industry was a vassal to the German chemical system. The immediate embargo placed by the Reich on the export of chemical products was not so much to insure their availability for war uses within Germany as it was to coerce both enemies and neutrals. This action rendered us, for the moment, almost impotent to meet the requirements of a major war. Fortunately for the United States, upwards of three years were to elapse before we had to marshal the resources of chemical industry to support our own war effort. In this interim were laid the foundations of our present self-sufficiency in every field of chemistry.

The Rise of American Chemical Industry

During the period of our neutrality it was necessary for us to turn our own resources to satisfy the chemical requirements of our industry. More than this, we had to provide the raws and intermediates that were absorbed into a burgeoning munitions program initiated in this country by the Allies in 1915. We were obliged to develop sources of raw materials, to build plants and develop the know-how to operate them. This amounted to a large order, one that could not be filled overnight. Yet American industry arose to the challenge, as it has to every challenge, either in peace or war.

In the blithe days that preceded 1914 we had appeared

MILITARY POWER

satisfied to leave the mysterious business of chemical concoctions to German hands, focusing our attention on other and seemingly more profitable forms of enterprise. When under the compulsions of war we began to treat the problems of American chemical industry with real consideration, we found them to be not only interesting but particularly attractive to the American genius. We became enthusiastic about chemistry and this enthusiasm is reflected in the history of World War I.

It is true that we had many chemical bottlenecks after we entered the war in 1917. Critical shortages developed so that we had to establish strict priorities and embargoes to insure that our then meager chemical resources would suffice for our most urgent war needs. Sulphur and phosphate rock are about the only raw chemicals I can recall that we had in ample quantity. Nitrates we certainly lacked, and toluene, and phenol, to mention only some compounds that were required for munitions production. But the chemical industry in 1917 and 1918 was just getting under steam. The plants we were building to come into production in 1919 would have met all our needs and more. It is quite evident now that the stimulus to our domestic chemical industry provided by the first World War—both the neutrality period and our year and a half of fighting—set it well on the way to maturity.

The introduction of gas as a combat weapon two years before we entered the war was a historic step in the penetration of science onto the field of battle. Like the atomic weapon, this chemical weapon was sold over the heads of the military to the highest political authority of the state.

In the United States scant attention was paid to this subject until we were actually at war. Then we took up chemical warfare with considerable eagerness. Our program, impressive though it proved to be, was largely the work of our chemical scientists and industrialists and reflected their enthusiasm for the potentialities of this expanding feature of our national economy. The Regular Army at that time was simply not prepared to provide very detailed direction of the measures necessary to insure our successful participation in gas warfare. I recall, now with some amusement and deprecation, my efforts as second lieutenant at Fort Benjamin Harrison in the summer of 1917, to instruct others in the methods of detection of and defense against chemical attack. Talk about the blind leading the blind!

Aftermath of the War

When, in 1919, we took up the problem of reorganizing the Military Establishment in the light of our recent combat experience, there was to be considered the disposition of the chemical service which had developed so remarkably during the war. The military affairs committees heard considerable testimony on this matter. Since there was conflict within the War Department on the issue, the views of leaders of chemical science and industry who had participated in the war effort were especially considered. The final decision of Congress was written into the 1920 revision of the National Defense Act. The chemical service (now Chemical Corps) became a permanent feature of our military structure. And I do not suppose that today anyone seriously questions the wisdom of this action.

This was only one indication of the Government's attitude toward chemistry as an essential adjunct to

GENERAL CHARLES L. BOLTE

our nation's growth. Another was the Chemical Foundation, which represented one of the few real prizes we drew from our first tangle with Germany. Through this agency U. S. chemical manufacturers were enabled to use, on equal terms, all German patents and process rights taken over by the alien property custodian. So, instead of falling off when war demands stopped, chemical industry in this country continued to move ahead. The varieties of commercial chemicals that had been produced by us before the war more than tripled. It was the post-war development of a self-contained American synthetic organic chemical industry that provided the keystone for the economy of abundance.

As I see it, our advances in the several fields of chemistry have been based on two essentials; trained scientists, and ample raw materials. The latter is part of our national heritage, which had merely to be staked out and developed when needed. The chemical knowledge is a more precious asset, which was not so easy to come by.

When I was a young student it was the accepted practice for chemists to go to Germany for advanced study. Now we seldom remember that this custom ever existed. It is our splendid system of scientific schools that makes possible our continued leadership in applied chemistry. However, it is foolish to suggest that the United States has—or can acquire—any monopoly on chemical brains. More important than the knowledge, more important than the raw materials, is the imagination and courage by which the two are fused. This is something that as Americans we cannot be denied.

The Booming Years of Peace

Although the outward aspects of our fighting strength were not spectacular in the peace years between the two world wars, a lot of spadework was accomplished during these years in the development of military-industrial relationships that proved later to be highly important. This was especially notable in the chemical field. Here we found a ready area for planning of industrial mobilization. It was not too difficult for the aggregate require-

(Continued on page 26)

AMERICA'S CITIZEN AIRMEN

By **LIEUTENANT GENERAL LEON W. JOHNSON, USAF**
Commander, Continental Air Command

For the fiscal year 1954, the United States Air Force received an appropriation of more than 11 billion dollars. A budget of that size means "big business." The Air Force, as the country's first line of defense, comprising an organization of about a million people, is "big business" in any executive's language.

Like most modern business organizations, however, the Air Force is dependent to a great extent on other businesses and organizations for support. Up to date developments in the aircraft and allied industries, in science, medicine, law, and countless other fields have kept our air arm strong. Without this cooperation the Air Force could lose its potency as the defense weapon cocked for initial retaliation against aggression.

For an appropriate example of the support rendered the Air Force by a particular segment of American business, one need look no farther than the participation of commercial air carriers in the Civil Reserve Air Fleet program. Jointly administered by the United States Air Force and the Defense Air Transportation Administration, the program provides for the immediate allocation of civil aircraft to the military in the event of emergency.

This dependence on American economic and commercial potential is not based on some nebulous concept of business as the impersonal face of our nation's factories, or markets, or shops. The Air Force relies on the support of thousands of the people who make up America's business world—the men and women of the Air Force Reserve.

This reliance, too, is based on good business principles. In times of crisis, the civilian components of the regular Air Force establishment spell the difference between a military police force and an effective striking force. If only in terms of plain dollars and cents, this must be so; the cost of maintaining a strong Regular organization sufficient to insure national security is prohibitive.

LIEUTENANT GENERAL LEON WILLIAM JOHNSON, USAF

General Johnson was born in Columbia, Missouri, September 13, 1904, and spent his boyhood in Moline, Kansas. He was graduatted from the U. S. Milittary Academy and commissioned a second lieutenant in June 1926. He later received a Master of Science Degree in meteorology at the California Institute of Technology.

General Johnson was one of the first four flying officers of the Eighth Air Force and served as Assistant Chief of Staff for Operations for that command during its formative period. He accompanied the Eighth Air Force to England in June 1942. In January 1943, he assumed command of the 44th Bomb Group and, in June of that year, took the group to Africa on loan to the Ninth Air Force for the attack on the Ploesti oil fields in Rumania. For his part in that raid, General Johnson was awarded the Congressional Medal of Honor.

In January 1952, General Johnson was named Commander of the Continental Air Command at Mitchel Air Force Base, New York.

Strength Rests on Patriotism

In a recent issue of *The Air Reservist*, the official monthly magazine published by Continental Air Command for more than 300,000 Reservists, a story appeared which aptly illustrated the strength available to the United States through the loyalty and patriotism of its citizen airmen. The article described the participation in Air Reserve training of Staff Sergeant James A. Pacifico, a loom operator of Amsterdam, New York, and a veteran of B-17 missions in World War II.

The 88th Air Depot Wing, to which Sergeant Pacifico belongs, trains one weekend a month, Saturday and Sunday—in New York City. To be there, the sergeant takes the train from Amsterdam to New York City on Friday evening. The distance by rail is 175 miles. Elapsed time, one way, is four and a half hours. On Sunday evening, after training, he returns to Amsterdam. Sergeant Pacifico, the father of three children, is paid $24.48 for the weekend of training. His round trip fare is $13.85, his lodging costs about $4.00 and food comes to about $6.00. That adds up to about 24.00, which means he breaks even.

Asked why he goes to such lengths to be part of an organized Reserve unit, the sergeant does not indulge in mock modesty. Without hesitation, he declares, "I'm in the 88th for one reason—to help in the aerial defense of my country."

The candor of this young American in declaring his desire to help his country is refreshing. Too often, in discussions about the motivation behind membership in the Air Reserve, the remark is heard that we cannot recruit Reservists by appealing to patriotism. We should not subscribe to that notion. The old claim that Americans are shy of publicly admitting love of country, though privately ready to die for it, is getting a bit hackneyed. It is also false. The men and women of the Air Force Reserve are proud and willing to declare their patriotism. America's call to arms needs no more translation today for Air Force Reservists than did the midnight call of Paul Revere to the New England farmers in 1776. For graphic proof, the flood of applications for active duty that followed the Communist invasion of South Korea should suffice. If "the battle is the payoff," Korea proved that our dependence on the citizen airman paid off a thousand-fold and more.

Shortly after the Red breakthrough of the 38th Parallel, the United States called some 190,000 Air Guardsmen and Air Reservists to active military service. These airmen made up about 51 wings, and during a critical stage of the Korean fighting they represented more than 80 percent of the officer strength in the Far Eastern combat zone. Within two months of the invasion of South Korea, the United States Air Force had 20 wings operating in the theater. Among the organized units, the 437th Air Reserve Wing from Chicago was flying missions in Korea within 90 days after call-up.

Dependence Upon the Reserve

When the Korean conflict ended, the list of "jet aces" was headed by two Air Reservists, Captain Joseph McConnell, Jr., with 16 MiGs to his credit, and Captain Manuel Fernandez, Jr., who destroyed 14 of the Communist Jets.

There were many people who were amazed at the speed at which our airmen flew into the Korean fight. To Air Force officials responsible for the Air Reserve Training Program, the operation was not a surprise. Since World War II, the Air Force had been striving, within the limits of available funds, to keep up the wartime efficiency of thousands of combat trained pilots, aircrews, technicians and ground personnel.

This training is still going on today, administered by the Continental Air Command (ConAC), whose military "family" consists of some 350,000 male and female citizens of the United States engaged in workaday tasks in banks, stores, factories, salesrooms, offices and homes across the country. These are the men and women on whom the strength and efficiency of our Air Force depend. Without them, there could be no air arm worth the name. We see thousands of them, in Air Force uniforms, on various weekends each month when they report to organized Air Reserve units for training. The work they do is every bit as important to the security of the United States as any work accomplished anywhere in the nation today.

At the operating level of ConAC's Reserve program, numerous Training Centers throughout the country prepare Reservists for duty in the several missions and skills demanded by modern air warfare. The Training Centers, in essence, are "housekeeping" organizations for various types of Reserve units. They are manned by active duty officers and airmen who form the "permanent party" and who act as instructors and supervisors in the operation of combat flying outfits, pilot training schools, and maintenance and supply depots. At present, ConAC has 25 of these Reserve Training Centers, each acting as the "Counselor and Friend" to a Reserve Wing assigned to it. More than 9500 Reservists, including 2000 pilots, belong to these organized Reserve Wings. They are the men and women we brush up against every day in buses, trains and public places, the men and women intent on the business of America in our offices and shops. They, with their fellow Reservists of the Army, Navy and Marines, are the patriotic core of America.

A random look at some record cards identifies a group of Air Reservists as typical of a montage of American citizens appearing on the neighborhood movie screen. Immediately, three representatives of the chemical industry come to the fore. There is Lieutenant John E. Marder, a weekend C-46 pilot assigned to the 512th Troop Carrier Wing at New Castle, Delaware. During the week he is Mr. John E. Marder, a petroleum laboratory assistant at the Chambers Works of the Dupont Industries at Deepwater, New Jersey. In his daily job, Lt. Marder checks the performance of various fuel mixtures to obtain data needed by petro-chemists in developing additives for gasoline and lubricants. On one weekend a month, and on a two week leave once a year, he sits behind the controls of a twin-engined Air Force transport as part of his unit's operational staff.

This particular branch of the chemical industry produces two other members of the 512th Wing. At the same plant, Miss Anna May Mollett is simultaneously a secretary in the pertoleum laboratory and a WAF assigned to the headquarters group; while Captain John Chrustowski, a training and administrative officer with the 512th, is a Methods and Standards engineer during the week.

A representative of the air transport industry is Brigadier General Clayton Stiles, of the 514th Troop Carrier Wing at Mitchell Air Force Base, N. Y. During the week, as Captain Stiles of United Airlines, he slips behind the wheel of a 74 passenger DC-6B airliner out of New York's LaGuardia Airport bound for Chicago. Down in Texas, the Air Force Reserve is ably, if not typically, represented by a pat hand—four of a kind. They are the 23-year-old Perricone quadruplets: Anthony, Bernard, Carl and Donald, of Beaumont, who are members of the 8706th Pilot Training Wing at Ellington Air Force Base. Starting their careers in the oil business after a tour of Army duty in Korea, the Perricones decided to join the Air Force Reserves as a family group. Ex-tankmen, all, the quads are assigned to duty as heavy equipment operators in the motor vehicle squadron.

Each Has a D-Day Assignment

The Wings to which Reservists report on their several weekends each have their particular "D-Day" mobilization assignment, depending on the type of operation for which designed. This enables the regular standing establishment to draw on a reserve reservoir of strength when implementing the responsibilities assigned to it in emergencies. In the event of mobilization, Reserve combat units would be assigned to the Tactical Air Command, while support units would become part of the Air Materiel Command. At the same time, our pilot training units would start serving with the Air Training Command to provide instruction for air-crews.

Members of Reserve Wings attend 48 drill periods of training annually and serve a 15 day tour of active duty every year. In fiscal year 1953, they flew nearly 57,000 hours, and up to February of the current fiscal year they reflected the increased tempo of training by logging more than 80,000 hours. In the past year, the transition to jet aircraft has increased and more and more jet instructors are being assigned to Training Centers to pass on their skills to Reservist pilots.

Similar training for airmen of the Air National Guard is supervised by ConAC as part of its mission of providing the nation's trained citizen airmen. Air National Guard tactical units are rapidly filling up with hundreds of the latest available jet aircraft. T-33 trainers, F-80s, F-84s, F-86s, and F-94s now are being flown by Air National Guard units.

Within recent weeks, the Air National Guard has become an integral part of the aerial defense net of the United States. Heretofore primarily assigned to tactical missions, the Air National Guard now contributes to the effectiveness of the interceptor force making up the nation's air defense arm. The changeover of the traditionally offensive air weapon of the Guard to defensive tactics is in line with our nation's policy of preventing war by putting would-be aggressors on notice that any action against us will be met at the source by instant retaliation.

An illustration of what the Air Guard's interceptor mission will mean in the training program can be seen in the new role to be assumed by the 140th Fighter Bomb-

(Continued on page 19)

CIVIL DEFENSE PROGRESS

By KATHERINE G. HOWARD
Deputy Administrator
Federal Civil Defense Administration

Mrs. Howard, in one year in office, has travelled more than 72,000 miles, speaking in twenty-three cities and eighteen states in the cause of Civil Defense. In this article, prepared especially for the Journal, she gives us some of her philosophy on the subject and her views as to how the program is getting on.—Ed.

Mrs. Katherine G. Howard, as the first woman to serve as Deputy Administrator of the Civil Defense Administration, sees her job as follows:
"I have dedicated myself to the *perpetuation* of household responsibilities, not to their abandonment. As I see it, my job is to prepare people to *live through* an atomic attack, not to die in one; to *keep* their homes, not to lose them; to *protect and preserve* their families, not to scatter and dissolve them; to *hold and work at* the jobs of their breadwinners, not to give them up; to survive and win over any attacks that may be launched against our home communities, not to collapse under them in abject helplessness."

WE want Civil Defense to be something we can make room for in our daily lives, without going overboard about it, as in any other community activity. Most of us want to do our part in Civil Defense, as in every other good cause. But we want to run *it*, rather than having *it* run *us*. And that, I think, is the kind of Civil Defense worth having.

Some of our public understanding of the need for Civil Defense has been slow in coming, and some of it has been painful. A nation like ours cannot arrive at an informed opinion on anything as important as Civil Defense without struggle. We do not move in such matters until a majority of our individual citizens have worked out, in their minds, a desirable course of action, and have seen the necessity for taking that action without further delay.

In America, each of us has the right to decide for himself whether or not a thing needs doing for the common good, and whether or not he personally can help do it. We have been exercising that right in this country, individually and collectively, in reaching a decision about Civil Defense. We have determined that we need it—and that it needs *us*.

In the year, just over, that I have been with Civil Defense, I have traveled 72,496 miles, attended civil defense regional conferences, visited disaster areas, spoken to various groups in 23 cities and 18 states, and addressed innumerable radio and TV audiences. From my observations, I can honestly report a marked and continuing increase in interest in Civil Defense by the American public and, even more important, a more realistic attitude in Civil Defense planning.

Strange and Unaccustomed Dangers

War today with the concept of total effort brings strange and unaccustomed dangers to civilian populations. Nuclear weapons, new explosive mixtures, extraordinarily toxic materials and biological agents, must be faced now not only by the soldier, but by civilians far behind the front lines.

Chemical warfare against civilians is a possibility, either in the form of an accessory to high explosive bombing, or alone in a surprise attack. The respiratory system is particularly vulnerable to the action of the nerve gases, which are toxic in concentrations so small that they represent a real threat to the densely-populated areas of this country.

For some time the Federal Civil Defense Administration has assumed, on the basis of intelligence reports and the conclusions of our military leaders, that the Soviet Union has the capability of striking any target in the United States. The main attack presumably would be delivered by air, and would consist principally of atomic weapons detonated above ground during normal working hours—when congestion in our cities is heaviest. Additional weapons might be used simultaneously—such as high explosive and incendiary bombs, biological and chemical weapons, sabotage, and psychological warfare, to induce panic.

The atomic era in which we live has advanced so swiftly that we must make it our business to understand the extent and significance of this development. We are

dealing with nuclear weapons of ever increasing size, power, and capability.

President Eisenhower announced before the United Nations General Assembly last December:

"Atomic bombs today are more than 25 times as powerful as the weapons with which the atomic age dawned, while hydrogen weapons are in the ranges of millions of tons of TNT equivalent . . . Let no one think that the expenditure of vast sums for weapons and systems of defense can guarantee absolute safety for the cities and citizens of any nation. The awful arithmetic of the atomic bomb does not permit of such an easy solution. Even against the most powerful defense, an aggressor in possession of the effective minimum number of atomic bombs for a surprise attack could probably place a sufficient number of his bombs on the chosen targets to cause hideous damage."

Our problem is one of individual responsibility. Our choice is starkly limited. Either we must get ready to protect ourselves, our families and our homes, or we must take a chance on being somewhere else when and if disaster strikes. And since there really aren't many places to hide and still be within reach of our jobs, our homes and our schools, we'd better be ready, just in case.

Supply Readiness Gives Concern

To meet a disaster of this magnitude, Civil Defense must concern itself with readiness in two areas. There must be readiness in things, such as medical supplies and rescue equipment. And there must also be a readiness of people. Not only must doctors and nurses and first aid people, and auxiliary policemen and firemen, and utility workers be ready—but plain ordinary people must be ready too; people whose chances of escaping with a whole skin or, at worst, minor injuries can be doubled if they know what to do when the warning signal sounds.

Getting ready the *things* we need for Civil Defense is comparatively simple. It requires mostly money—though Congress has not always shown an awareness of that fact. However, since such things as burn dressings and surgical equipment and fire trucks and bull-dozers and spare water pipe need to be stored only once, we are gradually accumulating some semblance of a readiness in *things*, as represented by our emergency Civil Defense stockpiles throughout the country.

We still do *not* have adequate supplies of many things, and in some types of medical supplies we have only enough for a very few days of post-disaster need. But we are making progress in assembling things as fast as Congressional appropriations will allow.

I am happier—very much happier—about our gains in the readiness of people. For us in the Federal Civil Defense Administration, as for State and local Civil Defense directors, the problem of an alert and prepared people divides itself into three parts. We need first of all, of course, a hard core of skilled professionals in the many and complex crafts that enable our modern civilization to function.

If you will ask around a bit in your own communities, I think you will find that your electric light and power people, and your gas man, and your sewage and water plant employees, and many of your local contractors and their crews, have had civil defense briefing. So have your bus and cab drivers, and your communications workers, and your policemen and your firemen. They have taken part in test rehearsals. They know what would be expected of them if an emergency occurred. And they are ready, as always, to do their duty to the last man and woman.

These invaluable specialists had to be enlisted first because Civil Defense is—first of all—an extension of the regular protective services upon which you depend for the safety of your home. You will find, in fact, that a sizeable proportion of the more than 4 million Civil Defense workers on our books today is made up of this same hard core of specialists plus other government and municipal employees and industrial workers, and we can thank our lucky stars for their diligence and sincerity.

The next group of people that concerns us is the band of volunteers upon whom every community must depend for hard unselfish service toward the common good. I include here the block wardens and the rescue crews and the first aid trainees who have given so much of their time and effort to the learning and practicing of their responsibilities.

I include also the doctors and nurses who have sacrificed what little spare time they have to the study of health services and special weapons defense against radioactivity, nerve gas, and other modern threats to our civilian population. In many states and cities this sort of readiness on the part of skilled and willing people has produced gratifying Civil Defense results.

Program Lags in Some Areas

In others—Civil Defense progress has been agonizingly slow. The Civil Defense Act of 1950 declared it to be the intent of Congress to vest the *operating* responsibility for Civil Defense in the states and their political subdivisions; meaning the counties, the cities, and those most irreducible of all political subdivisions . . . individual citizens. According to law, it is up to responsible indivduals to prod their local Civil Defense organizations into action if results are not already evident.

Thus everything in Civil Defense boils down, in the end, to the readiness of the individual and the family to withstand attack. In case of a mass assault upon a community there would be only two kinds of people left afterward—those who *needed* help, and those who *could* help.

The difference between the two might very well lie in the amount of Civil Defense information, training, organization and practice the community has had. And those are things that cannot be imposed upon home neighborhoods from without. They must spring from within; from sober, adult realization of the security problems we face, and from intellectual and moral conviction that we must do something about those problems—personally and collectively.

PROBLEMS AND PROGRESS IN DEFENSE PLANNING

From an address before the Economic Club of New York, N. Y., on March 9, 1954

By

ADMIRAL ARTHUR W. RADFORD

Chairman of the Joint Chiefs of Staff

In opening remarks Admiral Radford noted that it was impracticable for him to tell all about defense planning in a few minutes but that he might discuss one or two facets of the subject in such a way as to lead toward a better understanding. He continued:

Communist Expansion

"Today, due to the massive nature of the Communist threat, we are in a period of tension and cold war. It could increase in intensity, and it could decrease. It could last ten or twenty years, or even for a century. You and I should prepare our plans accordingly.

"Communism is a continuing menace. It operates in global terms with global objectives. It has no time limit for the accomplishment of its objectives, and it can attempt to achieve its goals at any time it is expedient.

"Communism is also monopolistic and ruthless. It is governed by a small group of directors who can make sudden, and sometimes illogical, decisions. These directors are not responsible to any stockholders or customers, nor do they declare any dividends.

ADMIRAL ARTHUR W. RADFORD

"Worse than that, Communism is death on free competition, on small countries, and on small business. It has no hesitancy in putting the squeeze on a neighbor with a view to eliminating the competition, and amalgamating it into its own vast expanding corporation.

"Indeed, Communism is a total menace.

"The Soviets' one big goal, of course, is World Communism and World domination. That was the dream of their revolutionary architects. In Lenin's eyes, however, World domination was not to be achieved without a struggle. Lenin explained this in his writings when he said:

> " 'We are living not merely in a state but in a system of states and the existence of the Soviet Republic side by side with imperialist states for a long time is unthinkable. One or the other must triumph in the end. And before that end supervenes, a series of frightful collisions between the Soviet Republic and the bourgeois states will be inevitable.'

"The Soviets have a big start toward their goal. The processes of Communism have made the Soviet Union the largest colonial power the world has ever seen. In the short space of 15 years, the Soviets have 'colonized' some 640 million people, and millions of square miles of land, complete with homes, factories, and resources.

"What this means is that the Free Nation coalition can ill afford to let a single additional area fall behind the Iron Curtain. Though it often seems unclear, and is sometimes deliberately obscured, it is as simple as A-B-C. Aside from the tragedy to the people conquered, Soviet domination means that these people and their resources will be harnessed to the Soviet war machine, and may be turned against us.

"In my opinion, when any nation falls victim to Soviet aggression, whether internal or external, the Soviet Union becomes stronger, and U.S. safety is lessened. If Communism is permitted to gobble up parts of the World one by one, the day will come when the Soviet Bloc will be so powerful that no corner of the World will be safe.

"Indeed, Communism has many tentacles, and there are many prizes. One 'prize' example is Indochina where Communist infiltration, insurrection, and aggression constitute a serious problem.

Indochina

"Indochina is of special interest to us because its loss would imperil directly the whole of Southeast Asia, and indirectly a much wider area. If Southeast Asia fell into the Communist sphere of influence, more millions of people would lose their Freedom. Important raw materials and markets would be denied to Free Nations except on terms dictated by Communist Peiping and Moscow. The Communist potential strength would then be increased. The Reds would be that much stronger, and we would be that much weaker.

"Thus, it was apparent that it would be necessary to do more in the Far East. Accordingly, we have made available substantial additional resources to assist military defense efforts in Indochina, and to defeat Communist Viet Minh aggression.

"This war in Indochina has raged for over seven years. The military forces of France, Vietnam, Cambodia, and Laos have been fighting with considerable sacrifice of life and treasure. The peoples and the armies involved have had our support . . .

"In consonance with our long established policy of rendering material assistance and moral support to nations threatened by Communist aggression, the United States has supplied much of the material means to help them fight against it. We plan to continue such military assistance programs, and to cooperate with our friends in Indochina.

Collective Security

"Indochina is but one part of the over-all conflict between Communism and nations which want to be free. All in all, the Free Nations constitute the chief obstacle to Soviet aims. Collectively, they must be kept politically, economically, and militarily strong.

"Prior to 1950, the United States liquidated the most powerful military machine in American history, and placed it at such a low level as practically to invite aggression.

"When the Korean War began, no one was sure what it meant. No one knew whether it would be confined to Korea, or whether it portended a global war. We had to generate military strength as quickly as possible.

"This we did. Our Armed Forces expanded hastily to a strength of three and one-half million men and women, and our military aid programs helped to generate additional forces amongst our Allies. Our major course of action to deter war was the development of such strength, by a combination of alliances and forces, that the Communists would recognize, in advance, the cost of further aggression.

"In four years' time, collective Allied military strength improved. You may not realize how much. There has been a greater increase in Allied military strength during the past four years than there has been in the Communist Bloc. At the same time, of course, we had farther to go, and Korea provided the impetus.

Planning U.S. Forces

"But an important question was left unanswered. For several years, we had been building our forces for a particular peak year-of-crisis, but what was to be the pattern after that? What size and deployment of Armed Forces should we have in the light of the Soviet threat, the existence of atomic weapons, U.S. commitments, our limited manpower, and the national economy for the long pull?

"The question faced the new Joint Chiefs of Staff when they took office last August. It most assuredly would have faced any set of Chiefs, at that time.

"Since it is impossible to forecast precisely the year and the amount of maximum military danger, part of the answer was to provide a sturdy military posture which could be maintained indefinitely over an extended period of cold war. Part of it was to take advantage of new weapons and technological developments. Another part was to improve the readiness of our Reserve forces to meet today's requirements for rapid mobilization. Still another part was to adjust the balance of U.S. forces so as to fit into the larger system of collective Allied forces.

"We tackled this problem by making a reappraisal of our security requirements appropriate to our current and prospective situation.

"Here, I might take just a moment to assure you that: Our planning does *not* subscribe to the thinking that the ability to deliver massive atomic retaliation is, *by itself*, adequate to meet *all* our security needs. It is *not* correct to say we are relying exclusively on one weapon, or one Service, or that we are anticipating one kind of war. I believe that this Nation could be a prisoner of its own military posture if it had no capability, other than one to deliver a massive atomic attack.

"It should be evident from the forces we intend to maintain that we are not relying solely upon air power. We shall continue to have over a million men in our Army, and we shall continue to have a Navy that is second to none. We have never before attempted to keep forces of this size over an indefinite period of time.

Relative Emphasis

"The program for our Armed Forces is more a matter of emphasis. We are putting emphasis on our advantages . . . our long suits . . . in other words, on air power, on new weapons, and on a high state of combat operational readiness. We are placing emphasis on a ready Reserve, mobility and flexibility . . . not for any one date, but for now and for the indefinite future.

"As the importance of air power and new weapons increases, it does not necessarily mean that the importance of ground and naval forces decreases.

"Actually, each of our Armed Services is essential. Each has vital roles to perform. By no means are we divesting ourselves of our capabilities in other essential arms and forces. The effectiveness of the Army, Navy, and Marine forces will continue to be improved with better equipment, new weapons, and a better planning of Reserve components. We must have strong, mobile, combat-ready units capable of being projected wherever required.

"Not only that, we must have Allies. We recognize that the safety of the United States cannot be assured by the United States alone, indispensable as that is. The prudent course calls for a steady military coalition with our partners, sustained and planned so as to use our joint capabilities with maximum efficiency and minimum strain.

"We also recognize that the Free Nations are face to face with a totalitarian system and its inherent dangers of a shooting war. The Soviets enjoy a competitive advantage in that they can control natural resources, mobilize manpower, adjust finances, and control their colonies with a directness and a simplicity which Free Nations cannot achieve. Within wide limits, they can marshal great amounts of military power or political and economic pressure by squeezing it out of a lowered standard of living for the masses under their domination. They are expert at continuing tensions and conducting cold war.

"But, we do not have to help make the Soviet Bloc stronger. From a military standpoint, we cannot afford to indulge in a traffic of strategic materials with which they could increase their combat war potential to the detriment of world peace. Beyond that, there can be no real profits from trade with aggressor nations which are worth the price of future security. I think we should continue to draw a distinction between trade which contributes to peace, and trade which contributes to war. If we do not, we shall be furthering the destruction of all we hold dear.

"Stopping Communism is more than just a military job. It is political, economic, and psychological too. We have to be able to counter threats in all these areas. Military programs must be complemented in these other fields by

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CHEMISTRY RIDES THE SUPER-JET

By Amos G. Horney
Chief Chemistry Division
Office of Scientific Research
Air Research and Development Command
Baltimore, Maryland

DR. AMOS G. HORNEY

Air Force Scientist Views "Space-Ship" Aviation as Essentially a Challenge to Chemistry which emphasizes present Deficiency of Fundamental Knowledge—Ed.

Introduction

Traditionally, in the Armed Services *chemistry* has meant chlorine, phosgene, and other common anti-personnel agents; explosives; ammunition; and gasoline. In recent years it has taken on new meanings: smoke bombs; fire bombs; nerve gases; chemical and biological agents against man, animals and crops; high explosives; and aviation fuel.

Those acquainted with the science and technology which made possible the proximity fuse, the atomic bomb, the hydrogen bomb, our many other complex but less spectacular weapons and weapon systems, realize that *chemistry* plays a far more significant role than is generally recognized as a necessary tool in national defense.

Chemistry, the science with its extensive technology and unique techniques, has made many important contributions. These have been significant both to the art of living and to the art of war and defense. This article emphasizes future chemical trends in the art of war and defense. It points out where additional contributions are needed.

Chemistry—What does it mean?

Before considering chemistry's role in national defense from an Air Force point of view—that is, its present and future role—let us consider what we mean by chemistry.

According to the dictionary, chemistry is the science that treats of the composition of substances and of the transformations which they undergo. In his text "General Chemistry," Linus Pauling states "Chemistry is the science of substances—their structure, their properties, and the reactions which change them into other substances," and that "Matter comprises all substances of which the physical universe is composed." All ordinary matter consists of atoms. The exceptional kinds of matter are the elementary particles from which atoms are made, such as electrons, protons, neutrons, positrons, mesons, etc.

One substance differs from another in the kinds and arrangements of its atoms. Thus atoms are the structural units of all solids, liquids and gases. They are extremely minute. For example, if a glass marble one inch in diameter is magnified to the size of the earth, its constituent atoms would become about the size of golf balls and tennis balls. The rearrangements of such atoms constitutes a chemical change.

Physical changes should not be confused with chemical changes. To clarify these differences, the following are examples of physical changes:

a. Ice on a leading edge changed into water and water vapor or steam by application of heat. (Exhaust gases or electric coils may be used as a source of heat.)

b. Softening a glass marble with heat. (The glass may then be drawn out into fiber which may be used as insulation or woven into cloth. Glass fiber and resin materials are important aircraft construction materials.)

Typical examples of chemical reactions or change are these:

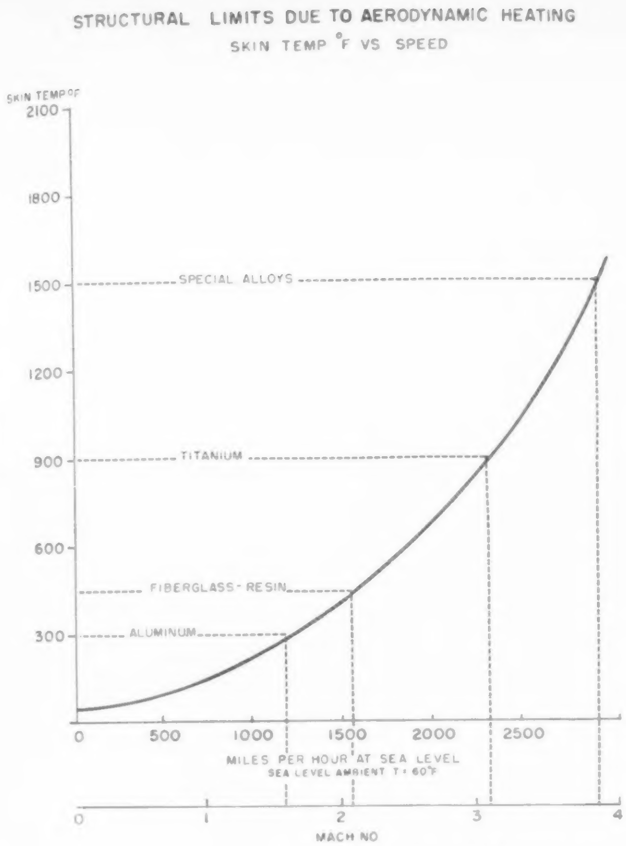
a. The reaction of hydrocarbons with oxygen when gasoline burns in air to produce carbon dioxide, water, incomplete combustion products and energy.

b. The reaction between aluminum of the wing fuel tanks and the purging gas which results in corrosion of the aluminum. (The exhaust gases are sometimes used to flush the air and gasoline vapor out of the empty or partially empty tanks to reduce explosion hazards.)

c. The reactions that take place when coal components, water and air are changed into nylon fiber.

Future Demands on Chemistry

Present trends in the applications of chemistry to the Air Force mission are treated in a separate article in this issue. As we survey these trends, it becomes obvious that super-jets, satellite vehicles, space ships and the mystery craft of 1964, 1974, and 1994 are only imaginative without super-materials for their construction and super fuels and lubricants for their powerplants. Specific examples of pertinent chemical problems con-



—U. S. Air Force Photo

As aircraft speed increases, the increase in skin temperature caused by aerodynamic heating is shown by this chart. The temperatures which limit the usefulness of certain aircraft materials and the corresponding limits to the speed of the aircraft are indicated.

fronting us with regard to materials, space and man follow.

The Combustion Mystery. One of the greatest problems of today facing the scientist in his research in rockets and combustion is that of unstable combustion sometimes referred to as "shriek"—pressure fluctuations which can shake the combustor to destruction in fractions of a second. An understanding of the origin and elimination of these unwanted "squealings" and "chuggings" yet remains to be accomplished.

Adhesion—What Is It? Disclosure would really slay a two-headed dragon. How does an adhesive bond hold two sheets of aluminum together? How does a lubricant prevent two bearing surfaces from siezing? In the search for airborne lightness we are replacing bolts, nuts, washers, and rivets with adhesive fasteners. The elimination of the hardware joiners also achieves weight reduction by the use of lighter yet stronger structural materials. The weight thus saved on the two British ultra-modern jet liners, the "Comet" and the "Britannia," is reported to be equivalent to the payload of passengers and freight. Yet scientifically we do not know what adhesion is or how to measure or test it without destroying the bond. Each individual problem of bonding must be solved by the "cut and try" approach. An adequate theory of adhesion is greatly needed as a guide to still better adhesives, lubricants and bonding techniques.

The Role of Metals and Alloys in the aircraft structure and power plant construction materials is obvious to all of us. Less obvious, however, is the fact that alloys are prepared primarily by fabrication and trial. The cost of making and testing millions of possible alloys is prohibitive and there exists a critical need for an adequate theory to predict the metal combinations desirable for tailor-made alloys.

The Elusive Latent Image. The foundation of a multi-million dollar industry, and the basis for aerial photographic reconnaissance is an elusive indefinite something called the "latent image." When light is stored in light-sensitive materials, such as photographic film, the effect is known as the latent image. Although the nature of the latent image is unknown, real images can be developed on photographic film by little understood chemical processes. These images in turn can be printed, using obscure chemical processes and thus producing what we commonly call pictures. Shall we say that, both figuratively and literally, we are working in the dark? Adequate theories and knowledge of the latent image and its development would guide us in our research as we attempt to have photo reconnaissance keep pace with aircraft speed. These theories also may point the way to new reconnaissance systems. The photo system is limited by darkness, clouds and haze. The challenge is a developable latent image resulting from the storage in a receptive medium of a radiation not limited by atmospheric conditions. In other words, to achieve all-weather capability, a new system of photography based on a non-visible radiation is required, or one which uses the old visible spectrum in a new manner which is unaffected by clouds and weather.

Weather—Prediction and Control. We all talk about the weather, but what can the chemist do about it? Interesting relations have been found between the ozone content of the upper layers of the atmosphere and weather conditions. Weather predictions, based on upper at-

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Physical changes should not be confused with chemical changes. To clarify these differences, the following are examples of physical changes:

a. Ice on a leading edge changed into water and water vapor or steam by application of heat. (Exhaust gases or electric coils may be used as a source of heat.)

b. Softening a glass marble with heat. (The glass may then be drawn out into fiber which may be used as insulation or woven into cloth. Glass fiber and resin materials are important aircraft construction materials.)

Typical examples of chemical reactions or change are these:

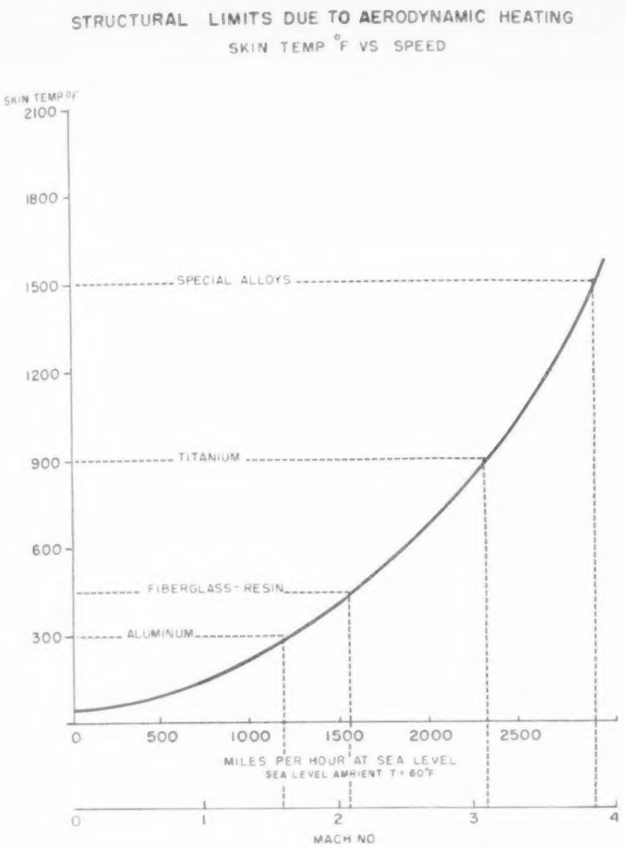
a. The reaction of hydrocarbons with oxygen when gasoline burns in air to produce carbon dioxide, water, incomplete combustion products and energy.

b. The reaction between aluminum of the wing fuel tanks and the purging gas which results in corrosion of the aluminum. (The exhaust gases are sometimes used to flush the air and gasoline vapor out of the empty or partially empty tanks to reduce explosion hazards.)

c. The reactions that take place when coal components, water and air are changed into nylon fiber.

Future Demands on Chemistry

Present trends in the applications of chemistry to the Air Force mission are treated in a separate article in this issue. As we survey these trends, it becomes obvious that super-jets, satellite vehicles, space ships and the mystery craft of 1964, 1974, and 1994 are only imaginative without super-materials for their construction and super fuels and lubricants for their powerplants. Specific examples of pertinent chemical problems con-



—U. S. Air Force Photo

As aircraft speed increases, the increase in skin temperature caused by aerodynamic heating is shown by this chart. The temperatures which limit the usefulness of certain aircraft materials and the corresponding limits to the speed of the aircraft are indicated.

fronting us with regard to materials, space and man follow.

The Combustion Mystery. One of the greatest problems of today facing the scientist in his research in rockets and combustion is that of unstable combustion sometimes referred to as "shriek"—pressure fluctuations which can shake the combustor to destruction in fractions of a second. An understanding of the origin and elimination of these unwanted "squealings" and "chuggings" yet remains to be accomplished.

Adhesion—What Is It? Disclosure would really slay a two-headed dragon. How does an adhesive bond hold two sheets of aluminum together? How does a lubricant prevent two bearing surfaces from siezing? In the search for airborne lightness we are replacing bolts, nuts, washers, and rivets with adhesive fasteners. The elimination of the hardware joiners also achieves weight reduction by the use of lighter yet stronger structural materials. The weight thus saved on the two British ultra-modern jet liners, the "Comet" and the "Britannia," is reported to be equivalent to the payload of passengers and freight. Yet scientifically we do not know what adhesion is or how to measure or test it without destroying the bond. Each individual problem of bonding must be solved by the "cut and try" approach. An adequate theory of adhesion is greatly needed as a guide to still better adhesives, lubricants and bonding techniques.

The Role of Metals and Alloys in the aircraft structure and power plant construction materials is obvious to all of us. Less obvious, however, is the fact that alloys are prepared primarily by fabrication and trial. The cost of making and testing millions of possible alloys is prohibitive and there exists a critical need for an adequate theory to predict the metal combinations desirable for tailor-made alloys.

The Elusive Latent Image. The foundation of a multi-million dollar industry, and the basis for aerial photographic reconnaissance is an elusive indefinite something called the "latent image." When light is stored in light-sensitive materials, such as photographic film, the effect is known as the latent image. Although the nature of the latent image is unknown, real images can be developed on photographic film by little understood chemical processes. These images in turn can be printed, using obscure chemical processes and thus producing what we commonly call pictures. Shall we say that, both figuratively and literally, we are working in the dark? Adequate theories and knowledge of the latent image and its development would guide us in our research as we attempt to have photo reconnaissance keep pace with aircraft speed. These theories also may point the way to new reconnaissance systems. The photo system is limited by darkness, clouds and haze. The challenge is a developable latent image resulting from the storage in a receptive medium of a radiation not limited by atmospheric conditions. In other words, to achieve all-weather capability, a new system of photography based on a non-visible radiation is required, or one which uses the old visible spectrum in a new manner which is unaffected by clouds and weather.

Weather—Prediction and Control. We all talk about the weather, but what can the chemist do about it? Interesting relations have been found between the ozone content of the upper layers of the atmosphere and weather conditions. Weather predictions, based on upper at-

(Continued on page 18)

ADMIRAL RADFORD

(Continued from page 15)

positive programs which are adequate to prevent the Communists from extending their domination.

"Let us not sit by idly, and watch a single additional nation fall behind the Iron Curtain. Let us not let anything happen which would help Communism grow stronger, and Freedom grow weaker.

Defense Planning

"Apropos of defense planning, the plans of the Joint Chiefs of Staff are *not* static, but will change as conditions change. Our plans are evolutionary. They are based on a sound combination of important planning factors, as well as the latest developments in weapons and equipment. They are designed for our own defense and for collective defense.

"Today's military program is one for attaining, and maintaining indefinitely thereafter, in an improved state of readiness, selected U.S. Armed Forces which give us a sturdy military posture, and which constitute the most effective contribution to the balanced collective strength of the Free Nations of the world.

"Should another major or global war be forced upon us, I feel confident that this nation would use *whatever* forces, and *all* the forces, necessary to insure the future security and survival of our United States of America."

CHEMISTRY RIDES

(Continued from page 17)

mospheric studies, rest on the knowledge of the chemistry of those layers. As a matter of fact, the upper atmospheric regions may be regarded not only as a riddle, but also as constituting a vast physical chemistry laboratory where Nature carries out her experiments on a gigantic scale. Here, she experiments with such phenomena as the bombardment of charged and uncharged particles, electric discharge, ionization by collision and photo-chemical reactions. Accurate observation and expeditious interpretation of data may lead to the use of new chemical agents for cloud seeding and to the development of significant techniques for weather control.

The Man at the Controls is faced with the common problems of survival. In addition, he is faced with the increasing hazards of extremes in heat, cold, low pressure and speed. Today's swank airliner cruises along at five miles a minute at a mere four or five miles above sea level. Tomorrow's bullet-shaped rocket will jerk one off the ground with a force that feels like a half dozen men jumping on his chest. It will carry him at speeds capable of setting the craft afire, into altitudes where lack of pressure can make his blood boil and where one of his hands in sunlight would sizzle, while the other one in shadow would simultaneously freeze. Chemistry must provide tailor-made materials for his protection against these forces.

Man is a physical, chemical system. Both in flight and on the ground the substances of his body may be exposed to and therefore react with many chemicals now utilized by the Air Force. Among these are nitric acid, fluorine, aniline, liquid oxygen, and hydrogen peroxide. Even though the toxicity—the chemical reactions with the substances of the body—may be known at sea level or ground level pressures, the toxicological properties of both new and old chemicals are practically unknown at the decreased pressures of the upper atmosphere. The time and concentration levels of volatile substances which will dull the exquisite judgment of the man at the controls is also unknown. We know the reactions of carbon monoxide and ozone may be fatal in low concentrations, but we do not know the effects—chemical or physical—of traces over long periods of time. The reaction of carbon monoxide in the exhaust gases threatens us at all altitudes. The reaction with ozone threatens us when the upper atmosphere is compressed to provide breathing oxygen or to pressurize the cabin.

Fundamental Knowledge Necessary

A review of these examples of Air Force chemical requirements will disclose a common deficiency—fundamental knowledge. Major advances, or "technological breakthroughs," are stalemated until research yields the necessary knowledge. Mere development or refinement of today's weapons will carry us only a short distance into the future. Tomorrow's technology will surpass today's only to the extent made possible by new knowledge gained through research. The Chemistry Division, like other Divisions of the Office of Scientific Research in support of the development program, is sponsoring research relevant to the Air Force mission. We recognize that chemistry—the science of substances—plays an important role in providing our nation with a superior Air Force in its attempt to conquer space with materials, power and knowledge.

With half a century of aviation behind us, perhaps it is now appropriate to anticipate future requirements by observing the present and extrapolating the future. The emphasis for national security continues to be on speed, altitude and larger pay loads at the least possible cost. Chemically speaking, we seek higher energy fuels and ways to use them more efficiently, and super high temperature materials for structures and power plants.

Ideally, we need compacted, stabilized monatomic hydrogen or its equivalent as a super fuel for our chemical heat engines. The same fuel with stabilized monatomic oxygen or fluorine as an oxidizer is needed to power our rockets and rocket engines. We would be delighted with a structural material of ultimate lightness, infinite strength, not subject to fatigue and which would maintain its strength properties with all known variations in temperature. As pointed out by Col. W. O. Davis, Chief of Scientific Research, the degree of our future success will depend on the degree to which substances can be tailored to meet requirements. Certainly, *chemistry* will play a most important role in helping to meet these requirements.

ATTENTION
ALL A. F. C. A. MEMBERS

Preparation of the 1954-55 Directory is in progress. Address changes or other corrections should be sent without delay to,

THE SECRETARY-TREASURER
A.F.C.A. Headquarters
2025 Eye St. N.W.
Washington 6, D.C.

AMERICA'S CITIZEN AIRMEN

(Continued from page 11)

er Wing of the Colorado Air National Guard at Denver. Currently under the supervision of ConAC's 10th Air Force, the 140th is slated to be placed under the supervision of an Air Defense Command wing. Their training, which in the past stressed tactical air-to-ground firing and bombing, will now be concentrated on the air-to-air firing essential to interceptor missions. Eventually, most of the 27 Air Guard wings in the country will be converted to interceptor forces.

Supporting the airborne citizen airmen and keeping the planes aloft through the myriad tasks required in administration, supply, maintenance and general staff work is the great mass of thousands of other Reservists whose duties keep them on the ground in the Air Force's shops and offices and airfields. The enormity of the interrelated duties encumbent on staffs of various Air Force headquarters demands that a high degree of training be constantly maintained. To accomplish this, and to keep Reservists up to date on current Air Force developments while maintaining their status and interest in the Reserve program, ConAC recently inaugurated the Air Reserve Center program. Fifty Air Reserve Centers throughout the country now utilize the great manpower potential of Reservists not affiliated with organized units. Before the end of the year ConAC expects to have 35 more Centers in operation.

At the Centers, which are located in selected central places, Reservists meet in two hour sessions at least twice monthly. Meetings usually consist of classroom-type instruction, with training films, speakers, and various aids and directives furnished by ConAC. Though membership and attendance is on a voluntary basis, more than 36,000 men and women presently are receiving general and specialized Reserve training under this system.

At many Centers, groups have been formed composed of people who possess a common skill or profession. By meeting to study and exchange ideas that will develop their particular skills and proficiency, these Reservists increase their value to the Air Force. A group of Reserve officers and airmen in the legal profession, for example, may meet as a Judge Advocate General's group to study certain aspects of their duties which they may expect to encounter on active duty. There are other groups who pursue specialized knowledge in such various Air Force career fields as aircraft engine maintenance, communications, air traffic control, etc.

The team spirit with which so many of these volunteer Reserve units are imbued is exemplified by Flight B of the 9465th Air Reserve Squadron, in Washington, D.C. Though not confined to a particular career field activity, this flight was organized and led at the outset by a WAF, Staff Sergeant Marion I. Chadwick. The unit has developed its own training program to hold the interest of its members and to qualify them for advancement. Before Sergeant Chadwick organized the unit, few airmen in the Washington area were active in the volunteer Air Reserve. Today, Flight B is unique in being the only all-airman Air Reserve flight. The members have taken advantage of their location in the nation's capital to secure the services of well-known speakers to brief them on international subjects and on various Government operations.

The administration of the Air Reserve program extends also to liaison with such affiliates as the Civil Air Patrol, Ground Observer Corps and Air Explorer programs. Since 1945, the Air Force has been vitally interested in the Explorer program of the Boy Scouts of America. More than 400,000 Explorers, boys between 14 and 18, throughout the United States are living a program of service to their communities and the nation that contributes immeasurably to citizenship and patriotism. Well aware that a great part of the fundamental national strength rests in American youth, the Air Force makes available many of its facilities, services and personnel to assist Explorers in their program. Members of many Reserve units throughout the country have inaugurated Air Explorer training programs with special emphasis on aviation. Many Explorer scouts, through the encouragement and sponsorship of Reservists, have enlisted in the Ground Observer Corps and by actual practice and service have learned the importance of maintaining constant aircraft spotter stations across the country.

The training program of the Air Reserve extends beyond the various Centers and the programs of affiliated organizations into the homes of Reservists through the Home Extension Courses of the Air University. Currently, about 25,000 Reservists are enrolled in these courses. In addition to knowing that these men and women are preparing themselves for possible active duty when needed, the Air Force is happily aware that behind each of 6000 specialist jobs now being held by active duty personnel there stands 6000 men and women Reservists earmarked for those jobs on mobilization. These "mobilization assignees and designees", as they are known, are performing on-the-job training in the positions which they would assume if called up. This permits the rapid reassignment to combat positions of active duty people and is an excellent illustration of the support the Air Force receives from a patriotic citizenry.

Individual Air Reservists are aware of their responsibility to provide an instantly effective combat air arm. Their readiness to meet sudden danger has been a tradition among American fighting men since our early settlers banded together in common defense of their hard-won lands. The peaceful skies above us are no less menacing to today's Reserve airman than the surrounding forests of the early colonies were to America's frontiersman.

The spirit of cooperation and loyalty demonstrated by Reservists of our Armed Forces should be a source of intense pride to all Americans. Twice, in little more than a decade, they have been called upon to contribute the effective functioning of our regular military establishments. They have proved that the security of the nation rests in the hands of the civilian soldier, sailor and airman.

CHEMISTRY FLIES

. . . The Chemical Formula for Air Power

By Irving Poretz*

Materials and Components Division,
Directorate of Industrial Resources,
Office of the Deputy Chief of Staff for Materiel,
United States Air Force.

The Air Age . . . Chemistry in the Air Age . . . Indeed, the *New* Air Age by means of Chemistry . . . Chemistry Flies!

The New Air Age is underway mainly because outstanding men, through a concerted effort, have developed excellent new materials, worked them in ingenious ways and effected an optimum utilization of our industrial resources.

Superiority in the New Air Age will be maintained only through a relentless follow-through of prior and current achievements in working with substances already made available to us, as well as continuance of research for new materials. Chemistry, the science primarily concerned with all substances, will continue to make many important contributions in effecting such air superiority. To meet ever-expanding performance requirements for aircraft and missiles, many new materials of natural and synthetic origin developed for specific applications can be expected to be evolved.

The following sections are intended to show progressive chemical developments vital to the Air Force mission. These sections could be greatly extended, but the areas described are typical of those encountered in Air Force operations and are intended to emphasize the scope of chemicals applications involved. They include basic illustrations of research and development in chemistry and chemical technology. Such work provides the fundamental knowledge and "know-how" which, in turn, enables industry to progressively follow-through and to provide the necessary materiel for exacting Air Force requirements.

Aero Textiles

Nylon, fiber glass, dacron, teflon and dynel are but several of many man-made fibers pressed into service to resolve many interesting Air Force problems. They are used in making aircraft drag chutes, personnel and cargo parachutes, glider tow lines, special webbing, tire cords and other important items. Chemical treatment of textiles made from natural fibers has greatly enhanced and prolonged their natural properties in world-wide environments of temperature and humidity extremes, fungicidal damage, electrostatic effects and chemical contamination. Chemical treatments have made textiles fire and water resistant and protective from many chemical warfare agents, thus contributing greatly not only to the comfort and safety of personnel, but to the actual survival of the individual as well.

An interesting illustration of the manner in which synthetic fibers helped to resolve an Air Force problem concerns the popular B-47 aircraft. Most jet-propelled bomber aircraft because of their high landing speeds require long runways to provide sufficient rolling distance to bring them to a halt. These high speed landings could accelerate the wearing out the brakes and result in costly replacements and loss of vitally needed flying hours. Also, the constant application of the brakes causes severe abrasion to the tires. Heat generated during the braking action builds up high temperatures and pressures within the tires: blowouts might occur causing violent and unexpected swerving of the airplane, possible overturning or nosing-over, with resultant damage to or loss of the aircraft and serious injury, if not death, to members of the crew. Thus, the requirement for extensive runway length and continual replacement of tires and brakes posed serious problems to the operational capability of USAF jet-propelled bomber aircraft. Nylon, a light weight fiber capable of withstanding great opening shock has provided a valuable assist. It is a long way from "Hexamethylene-Diamine" and adipic acid" to a braking device for a high speed aircraft. That distance has been covered through chemical research and development plus imagination and typical American ingenuity. Today we find nylon fabric in parachutes which are deployed from the tail of the B-47 and other jet aircraft during landings. The drag effect produced by the "chute" contributes immeasurably to safe and efficient braking of the plane; it extends by a factor of 12 the useful life of the braking system. The deployed "chute" has reduced by an average of 35% the runway roll needed to bring the B-47 to a halt. So chemistry has given us two immediate benefits—first, the USAF gets more flying hours per plane; second, we save many taxpayers dollars by reducing repairs to braking systems, and by reducing the number of tire changes.

*Assistance of the following members of the Staff of the laboratories at Wright Air Development Center, Research and Development Command, Dayton, O., in the preparation of this article is gratefully acknowledged. First Lt. Arthur J. Butter, Major Bert M. Cottrell, Jr., Capt. R. D. Haire, Dr. J. W. Heim, Mr. A. D. Keogh, Mr. George P. Peterson, First Lt. Malcolm J. Rogers, Jr., Mr. Bernard Rubin and Second Lt. T. F. Hanna.

On short runways, Air Force pilots can save their brakes and tires by releasing special landing parachute from the tail of the B-47.

Courtesy of General Electric Company

Now that the age of supersonic flight is with us, new fiber problems must be solved. In textiles, as in almost all areas of materials development, heat is a formidable opponent. At temperatures of 350°F and above nylon loses much of its strength or it may fuse. Obviously, due to these effects it would become unserviceable. The chemist has again provided a possible interim solution in the copolymer produced by polymerization of "terephtalic acid" and "ethylene glycol"—Dacron. This new fiber can be stabilized by a heat treatment process so that it maintains its strength when exposed to high temperatures (350-400°F) for extended periods. The Air Force is now evaluating Dacron and other fibers for those conditions where nylon cannot perform efficiently.

Fibers and fiber treatments, born in the chemical laboratory, will continue to prove valuable assists in the solution of many problems generated by the New Air Age. It is expected that they will meet the continuing challenge for increased heat resistance, strength and lightweight characteristics.

Aero-Adhesives

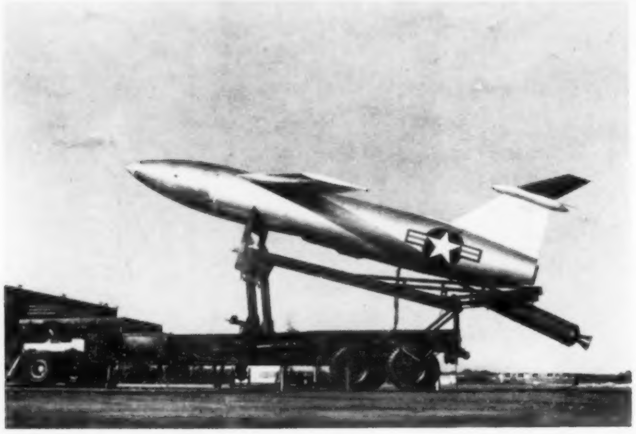
Metal-to-metal structural adhesives have effected probably one of the most dramatic changes in aircraft and missile construction techniques recently developed. They are products directly from the chemical laboratory which have become an important factor for aircraft structural design. Their significant role in aircraft and missile construction is readily understood by looking at their particular usages and by a glance at their characteristics which cannot be found in other types of fasteners.

The attachment of stiffener panels to the thin sheet exterior surfaces on the wings and tails of many aircraft is made possible by metal-to-metal adhesives. This application alleviates serious fatigue problems normally identified with riveted construction for this type purpose. Also, metal-to-metal adhesive construction permits use of thinner sheets of metal for exterior surfaces which results in significant weight reduction. When it was attempted to use thinner sheets of aluminum for the trailing edges of wings and tails assemblies, fatigue failures occurred at the rivet holes. Through the proper use of structural adhesives, uniform stress distribution is obtained over the area. Thus, adhesives permit lighter weight surface material by giving greater fatigue strength than rivet construction. Another asset of this application of adhesives as compared to the riveted assembly is the improvement of aerodynamic properties resulting from a smoother exterior surface.

The first Air Force structural adhesive was a nitrile rubber—phenolic. Further development yielded the Buna N—liquid nylon—phenolic—nylon cloth carrier. This adhesive was originally used in the B-36 wing construction. Shortly thereafter, polyvinyl phenolic type adhesives became commercially available, and they have found application in helicopter blade construction. The epoxide resins have the advantage of being the only single resin adhesive system. Current development effort is concentrated on such copolymer systems as the epoxide-phenolic system which has already demonstrated excellent high temperature (500°F) properties.

A very important contribution that adhesives have made to improved structural design is the aluminum

Structural adhesives make possible such large helicopter blades as provided on this aircraft.



The Matador, a guided missile, is a one-shot affair. Metal bonding with adhesives increases the pay load and aids in making manufacturing easier and quicker.

honeycomb sandwich material which they make possible. Rigid, low density aircraft components made from metal honeycomb cores bonded to metal faces exhibit especially desirable strength to weight ratios. Such metal honeycomb sandwich construction is used mainly in the floors and walls of cargo planes, throughout 100% of some helicopter rotor blades, and more recently in aircraft wings.

The use of structural adhesives in helicopter rotor blades demonstrates their advantages and superior properties more than any other application. All metal rotor blades being used today depend upon structural adhesives. Early helicopters, and their predecessor, the autogyro, were lightly loaded, and the majority of the blades were constructed with a round step, tapered steel spar with spot welded collars to which were attached the wooden ribs. As the helicopter became larger and as the loads on the rotor became greater, the blade spars began to fail. Investigation as to the cause of the failures indicated that fatigue cracks had initiated at the spot welds used to attach the collars to the blade spar. Under the action of high alternating loads generated by the rotor lag dampers, these spot welds had created sufficient stress risers to cause the failures.

A new design was required to eliminate the danger of stress concentrations in the steel spar of rotor blades. The problem was solved with the substitution of adhesives for the spot welds. As a result of this change, the service life of the rotor blades increased from approximately 100 hours per blade to over 2000 hours per blade.

The steady development of metal-to-metal structural adhesives has been stimulated from the obvious need for them in rotor blades. The important characteristics necessary in an adhesive for successful use in helicopter rotor blades are good shear strength, good fatigue strength, good peel strength, resistance to delamination, reasonable bonding pressures and temperatures, consistent strength over large areas, and stability when exposed to operating conditions.

The majority of the commercially available structural adhesives are produced as liquids or as tapes. The tapes, either supported by a fibrous cloth or unsupported, are the most popular due to their greater ease of use. Some liquid types are complete as a one part adhesive, but others require the addition of a catalyst or another liquid component to complete the system.

Continued improvement and development of structural adhesives is vitally important to the designers and fabricators of air weapons. Foremost is the present and rapidly increasing need for elevated temperature resistant materials. Today's adhesives are capable of withstanding exposure to 500°F for a maximum of 200 hours. Research programming is aiming at 1000 hours at 1000°F. As this goal is progressively approached, better structural designs for better aircraft will be made possible.

Aero Medicine

Aero medicine is concerned with enabling man to maintain physiologically the astounding pace set by continuous developmental achievements in the New Air Age towards ever increasing aircraft performance. Prophylactic and remedial measures against physiological damage by means of chemicals are an important part of aeromedicine. The Air Force, like its counterpart services, is dependent upon wonder drugs, oxygen, food concentrates, anti-biotics, biochemicals such as gamma globulin (a preventive for policmyelitis), dental resins, germicides, insecticides and many other chemicals to help maintain man's physiological efficiency in his aircraft and to permit his continued activity. An example of such application of chemistry in aviation medicine, with far-reaching benefits, is Aeroplast, a plastic dressing for burns and surgical wounds.

Aside from burns occasioned through battle damage fires, present day warfare, especially bombardment with nuclear reactors, brings with it the threat of hundreds of thousands of burn casualties produced within a moment. It is estimated that up to 85% of all casualties resulting from an atomic explosion will have thermal injuries. Current methods of burn therapy with time-consuming application of conventional dressings by trained personnel are entirely inadequate to cope with a disaster of this magnitude.

In view of this, the Aero Medical Laboratory of the Wright Air Development Center initiated research to develop an occlusive type of dressing which could be sprayed over a burn by relatively untrained personnel in minimal time. This was successfully accomplished through the use of a modified polyvinyl chloride acetate copolymer in ethyl acetate solvent. This form of local burn therapy has these advantages: (1) a marked saving of time over conventional pressure dressings in application; (2) the feasibility of its use by relatively untrained personnel; (3) transparency allowing frequent inspection of the burned area without removal of the dressing; (4) flexibility allowing relatively unrestricted early exercise of burned hands and digits without loss of integrity of the dressing; (5) impermeability to bacteria; (6) moderate bacteriostasis; (7) reduction of local loss of electroytes and fluids and sealing of proteolytic enzymes within the area of the burn, thus enhancing autodebridement and early sloughing of eschar in third-degree burns; (8) elimination of necessity for periodic resterilization; (9) minimal storage problems; (10) the absence of tourniquet effect on limbs and restriction of respiration when applied to the abdomen or thorax; (11) portability and feasibility of use under adverse conditions in the field; and (12) adaptability to the mass therapy of burns.

Aero-Synthetic Fluids

The range of temperatures internally and externally environmental to the operating systems of our modern aircraft is growing progressively. In many instances, it has reached the point where conventional hydrocarbon or other naturally available fluids will not perform their function satisfactorily in these systems. Today's high speed and high altitude aircraft require the operation of vital components through a temperature range of from

65°F to 550°F. Exacting performance with respect to viscosity, volatility, lubricity, oxidation stability and corrosion protection must be maintained under these conditions.

Polyglycols, esters, silicon organics such as the silicones and silicate esters, halogenated compounds and phospho-organic compounds have been especially useful in the development and application of aircraft lubricants, power transmission fluids, and heat transfer fluids. As of this writing, greatest utilization has been made of esters as a base for fluids for military aircraft applications. These products are described by performance specifications. They are formulated from an ester base to produce jet engine oil, hydraulic fluid, instrument oil, gear oil, general purpose grease, extreme low temperature grease and gun oil.

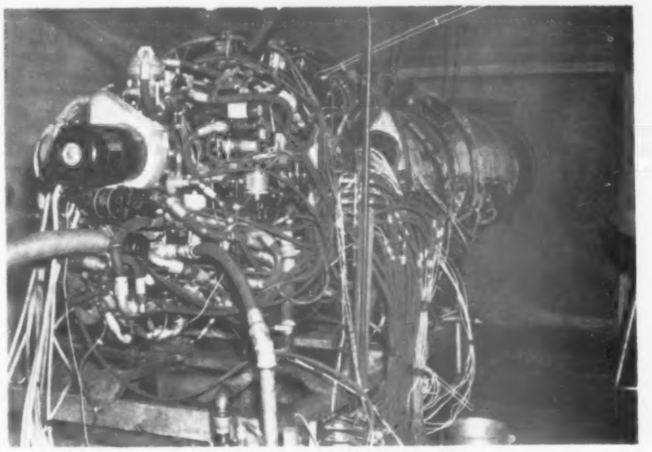
It is a rare occurance to synthesize a fluid of wide temperature liquid range and adequate viscosity—volatility characteristics which is not lacking in some other characteristic vital to the proper performance of aircraft component or system to which the fluid is applied. To provide for a practical fluid, we must blend in chemicals specifically designed to enhance or provide for the properties which are lacking. Thus, if increased rust protection is required of an instrument oil, one of the synthetic sulfonates may be the answer. If increased wear protection is required of a hydraulic fluid, addition of small quantities of a material such as tricresyl phosphate may help. An amine or phenol type oxidation inhibitor may increase the life expectancy of a hydraulic fluid or lubricating oil by preventing acid and sludge formation and metal attack. The additive should have the same stability under operating conditions as the base oil. The development of a satisfactory additive is often as difficult a problem as the base stock development.

Synthetic lubricants have proved they can perform satisfactorily in equipment such as instruments and electronic components which require long periods of operation without maintenance; they perform well in jet engines and equipment required to operate at extreme temperatures or over wide temperature ranges. We can expect these "tailor-made" molecules to continue to fulfill many new requirements being imposed by modern aircraft design. The chemical industry has followed through remarkably well in providing large scale production techniques for custom synthetic fluids.

Aero Rubbers

Natural and synthetic rubbers are used by the Air Force in tires, fuel cells, personal flying equipment and clothing, de-icing boots, gaskets, wiring insulation, hoses, "o-rings," survival boats, "May Wests," sealants and in many other applications where elasticity and flexibility are required. It is evident that the operation and design of advanced aircraft will be influenced by the ability of the chemist to develop rubbers and rubber-like polymers which are resistant to the effects of pressure variations, temperature extremes, environmental radiation and the chemical action of contact fluids, such as fuels, lubricants and hydraulic fluids.

For the satisfactory performance of some of our more advanced jet engines, they require a synthetic lubricant (basically di-2-ethylhexyl sebacate). At present operating temperatures of approximately 250°F, however, this lubricant is unusually destructive toward oil hose fabricated of even the best commercially available material ("Buna N" synthetic rubber, a butadiene-acrylonitrile compolymer) which must be frequently replaced. Furthermore, design requirements for the immediate future call for fuel and hydraulic as well as lubricant systems



Among the many tests before the hose is finally installed on aircraft for test in flight, is the test on an aircraft engine in a test stand.

to operate at temperatures which may exceed 350°F. At these temperatures, commercially available rubbers would be destroyed by a few hours contact with the synthetic oils, jet fuels or hydraulic fluids involved. Design around these problems? Perhaps, although aircraft manufacturers are very pessimistic about the possibility of designing systems which are completely free of rubber parts.

Development of improved resistance to synthetic fluids at high temperatures is but one of the many rubber problems which today confront the Air Force. Canopy seals, which are also used in windows and doors, must remain flexible from minus 100°F to over 400°F, and must be able to resist the effects of ozone, moisture, infra-red and ultra-violet radiation. They must also possess good cold flow, abrasion and tear resistance and cementability to metal. Tires must be able to take extreme landing speeds while heavily loaded and at high temperature, in addition to having good cut and abrasion resistance, low hysteresis and light weight. Coatings for radomes must have good mechanical properties, resist high temperatures, creep, and rain-erosion and must not interfere with radio transmission. For use in missiles, elastomers and structural adhesives are required which, for short

Afer requirement for a rubber item such as piece of oilhose is established, chemistry takes over for the synthesis and polymerization of selected experimental monomers.

periods of time, will retain satisfactory properties over exceedingly wide temperature ranges. All these are indicative of but a few of the general property improvements necessary for specialty rubber polymers for use in Air Force applications.

The need for materials with such extraordinary properties is often peculiar to the Air Force, and when the materials become available, the amount required will be relatively small when compared with the volume of "conventional" rubber polymers produced commercially. To produce the timely development of the materials required, the Air Force is actively pursuing appropriate research projects. The objectives of these projects are guided by future requirements for advanced aircraft and weapons systems. Chemistry must supply the answer!

Aero Photography

Reconnaissance, mapping and damage evaluation have long been recognized as important functions in the Air Force mission. Thus, considerable quantities of special chemical products are consumed in aerial photography. These take the form of special dimensionally stable film bases for mapping uses, unique high energy and high contrast developers, anti-fogging and selective agents, special pre-hardened emusions which can be processed at high temperatures to speed up processing, ion-exchange chemicals for the purification of wash water, surface active agents to prevent spots on film and chemical illuminants for night photography. Like other areas, however, new requirements in photography must be met through the new and unusual.

Present day nucleur research and armaments have developed a requirement for a new type of aerial photography which is insensitive to radiation effects. Xerography, also known as electro-photography, appears a promising solution to this requirement.

Xerography is a simple image-reproduction process based upon the use of an electrostatically charged selenium-coated metal plate. The charge is placed upon the plate in darkness. When exposed to an illuminated image, the illuminated plate areas lose their charge in direct proportion to the amount of light received. By means of powdered-cloud technique, black carbon is blown over the sensitized and exposed plate and the particles are retained by those plate areas still charged in proportion to their charge. In a matter of seconds, images are transferred to ordinary paper which has been given a special adhesive coating by means of a pressure roller. Normally, one paper copy is produced from each prepared charged plate.

Originally, xerography was developed as a black-and-white process for the reproduction of drawings. The Signal Corps, U. S. Army, improved the process to the point where it is now capable of producing a full continuous range of tones equivalent to those of silver halide photography. Adaptation to aerial photography was subsequently sponsored by the United States Air Force, working with the Signal Corps.

The use of the xerographic process in aerial cameras has presented a whole new series of problems in equipment design for complete airborne equipment. Research to date indicates, however, that eventually xerographic aerial photographs will have print quality and taking speed comparable to those characteristics of silver halide photography.

During laboratory tests, the process operated almost normally in the presence of strong radiation from an X-ray tube. Under the same conditions pieces of conventional silver halide photo film became heavily fogged. Lack of sensitivity to radiation is due not only to the difference in the materials used to get a picture, but to the fact that the materials used in xerography do not accumulate the effects of radioactive exposure prior to actual use. This is of great importance from a military standpoint, and conceivably could permit the taking of reconnaissance photography in regions contaminated by nuclear radiation.

Air Force development in the immediate future will take the form of an aerial camera magazine capable of use on any of a number of USAF standard lens cones.

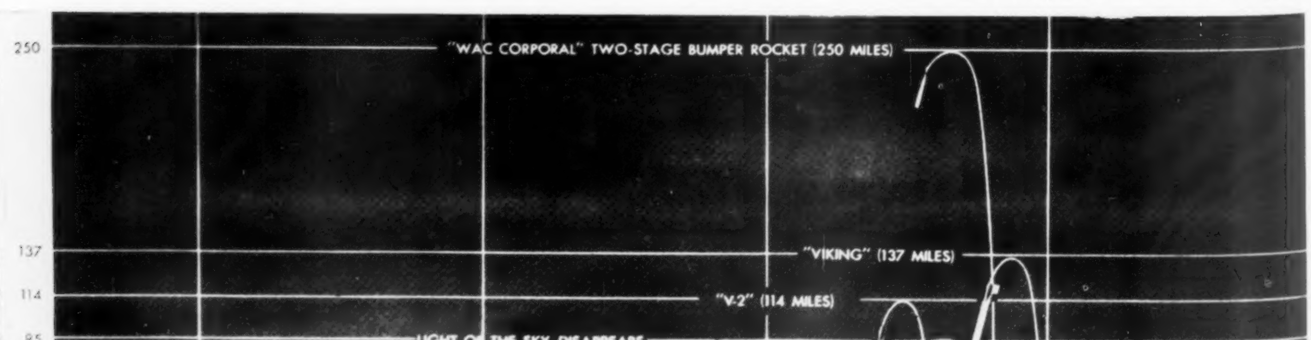
Aero Plastics

Through the clever use of resins and reinforcing materials in end item design, modern plastics are providing the Air Force with numerous important and critical items. Resins used include the acrylics, allyl and polyester low pressure laminates, alkyds, phenolics, silicones, polyethylenes, polystyrenes, vinyls, melamines, nylon, epoxys, new copolymers and new resin systems. Reinforcing materials include glass mat, fiber and cloth, asbestos mat, natural fibers and cloth, paper and metals. Typical of the end-items provided are jettisonable tanks, electronic components, piping, structural parts, target

(Continued on page 38)

Chart shows how, in a short space of time, engineers have sent rockets to previously unattainable heights. The next few years promise important progress in the conquest of space.

Courtesy of General Electric Company



CHEMICAL INDUSTRY

(Continued from page 9)

ments of all arms for bulk chemicals to be determined with at least fair accuracy and to prepare the specifications under which they should be procured. Through the agency of chemical procurement districts, each of which had an advisory group of civilian scientists and industrialists, contacts were made with the concerns that could produce what was required in a war emergency. This work was well advanced by the time the second World War began in Europe.

In 1940 appeared the first opportunity to exercise the machinery for military-industrial cooperation that had been built up in preceding years. By this time the United States was able to export both base chemicals and complex chemical compounds, in quantities as desired, without jeopardizing our own industrial or military positions. Lend-lease called for some expansion, as for example in aniline production, but on the whole this load was taken pretty much in stride. Our huge shipments of methanol, phenol, glycols, acetones, as well as caustic soda and potassiums, were indispensable to our friends in Europe during the years of our uneasy neutrality.

The Second World War

Actually there were few chemical bottlenecks in World War II. The striking contrast between 1917 and 1941 was that by the latter year we had in this country a great deal of chemical know-how which was reflected by the now-familiar towers, stacks, and steelwork of chemical manufacturing plants which studded our industrial landscape. Our scientific resources were brought to bear by the Office of Scientific Research and Development, three departments of which concentrated on problems of chemistry. The direct contribution to victory of our combined resources of chemical science and industry was impressive as to production of chemical weapons and the provision of essential ingredients called for in all phases of military, naval, and air operations. Not only were these necessities provided, but they were forthcoming with alacrity and good will.

On the military side, the war presented the first opportunity for a balanced test of our unique theory of centralizing in one agency of the Military Establishment the provision of means of the direct employment of chemical weapons in combat. Our thinking on these lines has been focused probably too much on toxic chemical agents, which represent only one feature of chemical warfare. In this respect our preparations proved adequate to support our national policy, which was to deter any enemy from attacking us with gas. The telling chemical weapon in World War II turned out to be the incendiary bomb, which in its final form was an American product. Less decisive than the incendiary, but of more immediate concern to the foot soldier, was the chemical generation of large protective smoke blankets on the battlefield, another innovation for which the Army is indebted to the combined efforts of chemical science and industry. Although we did not use gas, it is still true that chemical means played a distinctive role in our war operations.

The World of Today

After our 1945 victories in Europe and in Asia, our situation on the international chemical front was quite different from that which we occupied at the end of World War I. Then we were still struggling against lack of trained engineers and our goal of national self-sufficiency was still some distance ahead. Now we can enjoy the benefits of our accomplishments in perfecting plastics, in the recovery of hydrocarbons from petroleum products, in the field of medicinals, and in many other features of a balanced chemical system. None of the allegations as to shortages of munitions in our recent Korean operations can be charged to any lack of needed commercial chemicals; here U.S. chemical industry merely opened the pipe lines and our chemical requirements were promptly met. Our chemical resources today are not only adequate to our own needs, but they have supplied in the postwar years many of the needs of nations that support us in the continuing struggle for universal freedom.

While in Germany in recent years, I had some opportunity to observe at first hand how shattering the impact of war was upon the once-great German chemical industry. After 1918, the I. G. Farben trust continued practically unscathed. In 1945, allied control insisted on and effected a real and complete breakup of the old combine. This measure did not work out quite as expected, since it now appears that the components into which Farben Industrié was broken may be greater factors in the economic recovery of Germany, than they would have been under the old setup.

The Bädische Soda und Analin Fabrick at Ludwigshaven, for instance, was one of the more important components of the Farben combine. Following the war, it was in the French Zone of Occupation. The French Government continued its operation, supervised the repair of war damage, and increased its production. Today it is a major factor in Germany recovery. The same recovery can be said for the great plants at Höchst and Hüls as well as other lesser works.

An equally spectacular recovery has been made by Bayer-Leverkusen, where Dr. Gerhard Schrader first discovered the modern nerve gases in his insecticide research. I have been informed that 25 percent of the value of this company's business for the fiscal year 1952 was based on the processes for which the company had patent protection, resulting from intense research since World War II. It should be noted that all German patents were seized by the Allies and any patent protection that German industry now has is the result of new developments and patents obtained since the war.

However, German industry is undoubtedly crippled by many plant facilities being located behind the Iron Curtain and under Soviet control. Yet the center of gravity of the nation's industrial science remains, as always, in the western part of the country. Here men's minds are still free. This is one reason why Germany is back in the line of march of industrial progress, even though she may not soon again be leading the parade as she once did.

The revitalization now in progress is perhaps best reflected in the universities of western Germany. These continued to operate as best they could after the surrender. The universities, such as those of Heidelberg, Göttingen, Freiberg, Mainz, Marburg, and Munich continued to train students in scientific as well as other subjects, with chemistry a leading feature of scientific education.

While in Germany, I became acquainted with some of the outstanding scientists, including the then Rector, Sein Magnifizenz Professor Dr. Schmidt, and Professor Dr. Freudenberg, Dean of Chemistry, at the University of Heidelberg. I came to know also some of the scientists who had fled from the east. From these displaced individuals, the universities were able to recruit desirable additions to their faculties.

The many German institutes, such as those in Berlin and Heidelberg, were not disturbed, were even encouraged by the American occupation forces. Professor Rich-

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BUILDING FOR THE FUTURE

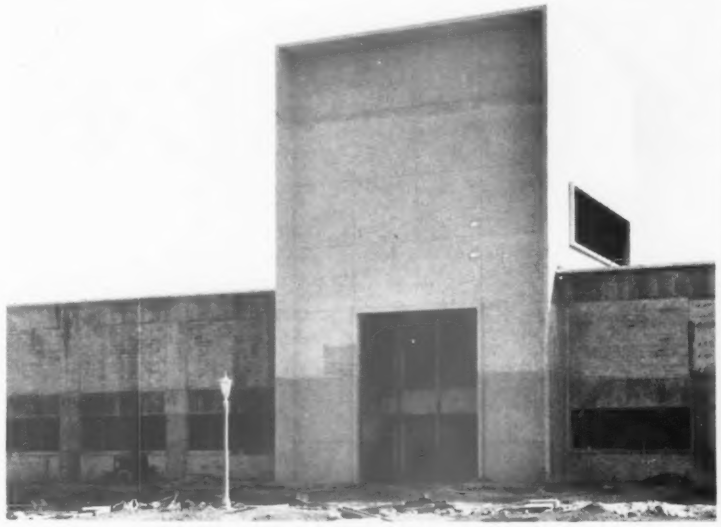
The Chemical Corps Training Command Construction Project at Ft. McClellan

By PFC LAWRENCE C. GUTMAN*

Fifteen months of building activity at Fort McClellan are showing impressive results as the Chemical Corps Training Command's eight million dollar project, destined to serve as the major portion of its physical plant, progresses toward completion. Completed it will be a substantial contribution to the Chemical Corps' program of developing a nucleus of men expertly trained in the means and methods of modern Chemical, Biological and Radiological warfare.

Centrally located in the Training Command area of the Fort, one-half mile south of the present headquarters building, the project is comprised of twenty-five permanent, reinforced concrete buildings designed in modern architectural style by Warren Knight and Davis of Birmingham, Alabama. These buildings will house the new headquarters of the Chemical Corps Training Command, classroom, laboratory and plant facilities of the Chemical Corps School, and will provide living and eating accommodations for students and permanent members of the Command as well as storage space for Chemical Corps materiel.

Each building is designed for a distinct function. Largest and most imposing of the group is the Chemical Corps School, built in the shape of a giant letter L, two stories high. A water cooling tower inclosed in a raised portion of the building directly over the main entrance is an important part of the air conditioning system for a constant temperature throughout the year. Much of the building is devoted to offices and classrooms, all thirteen of the latter containing abundant training aids equipment including motion picture projection booths, loudspeaker and amplifier systems, and motorized chart racks which an instructor can manipulate at the touch of a switch. There is an auditorium which has a seating capacity for



Closeup of part of the Chemical Corps School Building

500 persons and a two story library with reading and study accommodations as well as stack space. The building will also contain Chemical and Biological laboratories and concrete and steel, bank-type storage vaults.

Most unusual of the new buildings is the one to be used by the decontamination section. Rectangular in shape and completely air tight, entrance to it is afforded only through a double air lock device. Protective filter equipment purifies contaminated air from without and supplies pure air inside. The building is expected to fulfill a double function. As an academic building, it will be used to illustrate the means and methods for neutralizing the effect of war gases and biological agents on clothing

*Public Information Office Staff, Chemical Corps Training Command, Fort McClellan, Alabama.

Decontamination Building

Chemical Corps Training Command Headquarters Building

Radiological Defense Training Building

and human bodies. As a laboratory, it will permit study of the problems encountered in securing buildings and their occupants from the effects of chemical, biological and radiological materials.

Another interesting structure is devoted to Radiological Defense Training. This building consists of an office section located at a forty-five degree angle between two radiological laboratories. Only one corner of the central portion connects with each laboratory. This peculiar construction was selected so that radiological materials could be conveyed from a specially constructed radiological materials storage vault to the laboratories and back without exposing persons in the office section to radiation.

Two three-story buildings provide dormitory-type barracks for 1000 men. They are arranged as one complex with a connecting mess hall and are conveniently located near the Headquarters and School buildings. Each of these barracks, which will be occupied by enlisted men attached to the Command either as permanent party or as students, will contain administrative offices and recreational facilities. Officers will be quartered in separate 25-man Bachelor Officers Quarters.

A field instruction classroom will be used to teach motor vehicle repair and maintenance. The permanent motor repair shop and hardtop area for parking vehicles adjoin the classroom. Flamethrower shops and storage sheds, a printing plant, a warehouse and a central boiler house comprise the bulk of the remaining buildings.

Enlisted Men's Barracks

Construction of the project by the Shelby Construction Company of New Orleans began on 26 November 1952 at ground breaking ceremonies on its present site. Completion is expected this fall.

CHEMICAL INDUSTRY

(Continued from page 26)

ard Kuhn, designated for the Nobel Prize in Chemistry in 1938, vigorously pushed biochemical research work at the Max Planck Institute in Heidelberg, and the famed Professor Otto Warburg, also a Nobel Prize winner in Medicine and Physiology, did the same thing under adverse conditions in Berlin.

The great enigma of today is of course the USSR. The steady industrialization of the country under Communism could only have been accomplished with the support of a well-organized chemical industry. Yet, under the Soviet system, chemists, on the whole, are probably best in fields other than industrial. Soviet efforts to engraft German industrial competence on her own economy are in some sense pathetic. This discloses a weakness that may eventually prove fatal. The world can never be dominated by means of captured brains and pilfered formulae.

Tomorrow's Prospects

The major material asset of the United States, our great instrument for shaping the future, is armed strength integrated with industrial power. Such an instrument must be kept sharp. We must continue to research and develop, to study and progress, in industry and in the services.

It is particularly important, in my judgment, to maintain the sympathetic understanding that has developed between industry and the armed forces. When I was a young officer, industry displayed little interest in problems of national defense; while the Army, at least, was not overly concerned with the source from which it drew much of its strength. Today, mutual recognition of interdependence has brought the two together on a basis of friendship and understanding in such groups as the Armed Forces Chemical Association. Relationships of this type must be continued.

And we in the armed forces must continue to study and plan, even more intelligently than we have in the past. Our planning in particular must be in the hands of officers capable of recognizing the defensive possibilities of new developments in physical, chemical and the related biological sciences. We must know our needs, we must keep industry constantly informed of them, and we must quickly capitalize on the advances of chemical science and industry. On the maintenance of such progressive and cumulative strength largely depends the defense of the institutions of freedom.

CHEMICAL PROGRESS WEEK MAY 17-22

The Manufacturing Chemists' Association, Inc. is sponsoring a national program May 17-22 to bring to as many Americans as possible the fact that the science of chemistry as applied through the chemical industry is building an increasingly better America. This is a "grass roots" program and chemical companies are planning community activities including open house, plant tours and special events.

CHEMICAL CORPS INTEREST IN DISASTER RESEARCH

By DAVID B. DILL
Chemical Corps Medical Laboratories
Army Chemical Center, Md.

Mushroom cloud resulting from the thermonuclear explosion in Operation IVY carried out at the AEC's Pacific Proving Grounds in the Marshall Islands in the fall of 1952. In this explosion the test Island completely disappeared.

The fear aroused by the first chemical warfare attack in World War I was demoralizing. Many of those listed as casualties had not been injured but had seen their comrades hurt, smelled the gas and were sure that they themselves were injured. One United States officer recalls that in one mustard attack on his battalion every man became a casualty. In this and in other chemical attacks many men went to the hospital or were rendered ineffective even though they had not suffered any direct toxic injury.

About six years ago Chemical Corps Medical Laboratories proposed a research project on the psychological aspects of chemical warfare. Reasons for setting up such a project were manifold. For one thing no research had been conducted since World War I in this area despite the dramatic emotional reactions to chemical attack. More important, the newly developed German nerve gases threatened to be even more demoralizing if used in a surprise attack. A German document of 1942, described their nerve gas as the "first gas introduced into chemical warfare which damages the central nervous system and produces effects which, when seen, might well produce panic among the affected soldiers. This war gas has, therefore, an added effect on morale." Consultation with the Research & Development Division of the Army Medical Service led to an agreement to delegate their interest in such a project to Chemical Corps Medical Laboratories. This came about naturally since the Medical Services look to the Commanding Officer of Medical Laboratories for research on all the medical aspects of chemical warfare.

The need for this research project was easy to explain, but devising a research plan for attacking the problem was more difficult. It was decided that animal experiments in this field were of minor importance. It was clear also that experimentally planned mock chemical attacks were impractical; at least no one was found who was able and willing to stage such a simulated attack that promised both safety to those involved and realism. During this period the Texas City disaster and the Donora smog episode occurred. Both resembled in many respects chemical attacks. In Texas City a surprise explosion followed by fires, other explosions and toxic clouds engulfed a community of 16,000 people resulting in death to 512 and injury to nearly 4,000 others. Donora, a community of 14,000 people, accustomed to fumes which were unpleasant but rarely lethal, was exposed for hours to fumes having concentrations of toxic agents high enough to cause the death of 20, the hospitalization of 50 and reports of symptoms of poisoning from nearly 6,000 others. A study of these two disasters revealed that virtually all attention was paid to rescue, treatment and rehabilitation and that no group was on the scene to investigate human reactions to such disasters. It was agreed therefore that plans should be made for studying naturally occurring disasters whether or not panic was involved; from such studies it was hoped that sound principles would be derived on which could be based a manual for the use of officers who might be faced with disasters induced by chemical or for that matter, radiological or bacteriological attacks.

Discussion with many experts in the fields of psychology and psychiatry led to the decision to support two research contracts. One of these was with the University of Maryland. The Psychiatric Institute, headed by Dr. Jacob Finesinger undertook to study the effects on the individual of a disaster experience, that is, "studies in depth." The other, the National Opinion Research Center in Chicago, headed by Dr. Clyde Hart agreed to make "studies in breadth." Under these contracts trained interviewers have collected a mass of data at a variety of disasters involving communities: floods, hurricanes, explosions, fires and aircraft accidents. The data accumulated by these investigators have been tabulated and analyzed; we have been promised detailed reports some time this year. While no major disaster comparable to that in Texas City has occurred during the life of these contracts, all of those investigated have had something in common with a surprise chemical attack.

Under the first of these contracts, CML-632, the Psychiatric Institute of the University of Maryland employed Dr. John W. Powell as principal investigator of disasters. Dr. Powell has a Ph.D. from the University of Wisconsin and has had extended experiences in social studies, including psychology and sociology in several parts of the country, and has conducted psychiatric investigations

both for the National Institute of Mental Health and for the Henry Phipps Psychiatric Clinic of the Johns Hopkins University.

Dr. Powell and several assistants have investigated 18 disasters during the period 1951-53. The data collected are now being coded and interpreted; it is expected that a detailed report will be completed by June of this year.

One of the most useful contributions made to our understanding of disasters is the following analysis of disaster situations, prepared in outline form by Dr. Powell.

A. Descriptive Scheme for Disaster Situations

PRE-DISASTER CONDITIONING:

Social Patterns: expectations of behavior.
Belonging-group Patterns: expectations of leadership.
Knowledge or Folklore about the threatening agency.
Prior training in skills and roles; survival drills.
Individual response-pattern development; prior experiences of stress.

STAGES OF DISASTER

Pre-impact

I. *Warning:*

Danger is known but place and time of impact uncertain.
Precautionary activity may be initiated.

II. *Acute threat:*

Danger is localized and personalized. May be brief, or may last throughout the period of impact as in epidemics.
Survival measures may be taken.

III. *Impact:*

The duration of the *presence and activity of a destructive agency* directly threatening human life.
May be momentary or last from hours to days. *Initial* impact stage is "explosive" in terms of human response; *prolonged* stages are "erosive." That is, initial impact produces excitement; prolonged danger develops either indifference or chronic subclinical anxiety.

IV. *Inventory:*

Brief period of *recognition* of what has happened, and of *structuring* in terms of what can and must be done.

V. *Rescue:*

Extrication of self and others; temporary measures of survival, assembling the injured, calling for aid. Usually involves only those directly involved in the disaster.

VI. *Remedy:*

First-aid and emergency relief (food, shelter, etc.); usually involves trained and organized workers; firemen, police, doctors, nurses, ambulance personnel and hospitals. Salvation Army, Red Cross, National Guard, etc., may also intervene here.

POST-DISASTER RECOVERY:

Individual readjustment, recovery, rehabilitation.
Property reconstruction.
Community re-organization to former level of operations.

B. The Incidence on the Hospital

This falls into four familiar stages:
Alert.
Reception.
Pressure period.
Normal functioning.

1. *The alert* is usually sent from the scene, and is likely to be exaggerated on the basis of early rumors and fears.
2. *Reception* covers the arrival of the injured, the reorganization of out-patient and resident facilities, and the initiation of emergency administrative measures. This period may overlap with the next if the destructive agency persists for more than a very few hours.
3. *Pressure period* is the time during which clinic and hospital facilities are operating at maximum capacity, and additional professional and volunteer help has been enlisted from outside the institution, or even outside the area.
4. *Normalization* represents the ebbing of the emergency pressure and the remainder of the period during which the seriously injured are retained in the hospital.

All of these apply primarily to the *intact* hospital. Where the hospital itself is partially damaged, the other series of stages overlaps with this one.

C. Types of Disaster Situation

1. *Differences* in *behavior*, in psychological *response*, and in medical-remedial *management* are called for in different types of disaster. These types may be classified in two ways:

1. *Nature of the threatining agency*
Major differences here are:
   a. *Duration of danger*
   (e.g., explosion; gas leakage; contamination; epidemic).
   b. Possibility of *avoidance at discretion*
   (e.g. contaminated water vs. hurricane or flood).
   c. Types of injury predominating (e.g. burns, impact traumata, poisoning).

2. *Order and Duration of Disaster Stages*

"TYPE I"

a. *Prolonged impact with continued presence of* threatening agency, concurrent continuous *threat; brief inventory* which becomes public knowledge; early *rescue and remedial* measures; and *preventive* measures coincident with these. Early knowledge of the specific danger contributes to efficiency of precautionary and remedial measures.
Hospitals tend to be alerted early; clinic load tends to be *increased* by people with hysterical symptoms based on widespread popular alarm and identification with publicized victims. *Medical load* continues heavy with people who continue to report symptoms, as *publicity on precautionary and preventive measures maintains* public alarm, and certain types of personality personalize and dramatize this alarm in the form of symptoms.

"TYPE II"

b. *Repeated impact with mounting threat:* Stress is cumulative during early phase; *prevention* tends to take the form of *flight;* Rescue and

remedy are hasty because of fear-stress, if the cycle is short.

Hospitals (if intact) receive their impact in waves. *Psychological* breakdown tends to increase in proportion to the *intensity and duration* of threat preceding a given impact. *Medical* load, *other* than that injured, therefore, increases steadily but slowly, perhaps up to three months after the series ends.

c. *Single impact preceded by warning and brief threat:*

"TYPE III" *Inventory* is hastened by prior recognition of the nature of the danger. Rescue and remedy are prompt since security forces (fire and police) and medical agencies may have prior warning. *Hospitals* are usually *over*-alerted, and first reports exaggerate casualties. Post-crisis medical load not usually increased other than by continued care for severely injured.

d. *Single unhearlded impact:*

"TYPE IV" *Inventory* is delayed by need to figure out what has happened. *Rescue* is delayed by: (1) second shock, when *individuals* discover *mass* destruction; and/or by (2) readjustment to shock of unexpected blow; apathetic or dazed condition tends to be more widespread than in types 1 to 3.

Hospitals are *under*-alerted, but the medical load does not increase after the initial peak.

The National Opinion Research Center under Contract CML-2275 collected a large number of interviews with survivors of disasters. In the early stages the project was led by Dr. Shirley A. Star and in the later stages by Dr. Charles E. Fritz. In the words of Dr. Star* their objective has been, ". . . investigating . . . every aspect of human behavior that has to do with disasters." Their field studies were halted in 1953 and their data are now being converted to a detailed report which, it is promised, will be completed by June of this year.

It became clear in the first years of this project that interest in it was widespread in the Department of Defense. When Colonel Wood was transferred four years ago from his assignment as Commanding Officer of Medical Laboratories to become Chief of Research and Development in the Army Medical Service, he discussed this problem with his counterparts in the Navy and Air Force Medical Services. In Colonel Wood's words ". . . it became clear . . . that the . . . Federal Civil Defense Administration certainly had an interest as great as that of the Department of Defense in this field, and, furthermore, by law they had a responsibility in this field. So it was agreed that the best arrangement would be to draw up a joint program with the Federal Civil Defense Administration, and this was done by several conferences."

". . . the objective in this proposal was first to determine the mass and individual psychological reactions of our people in major disasters, sociological upheavals which are brought about by these disasters, and the rescue, medical and logistic problems involved in adequately handling these disaster situations. We wish to determine the effectiveness and failures of both the spontaneous and the organized rescue efforts in such disasters, and to develop sound data upon which both civil and military defense disaster planning could be based."

The detailed proposal can be found in an unclassified section of a document of the Research and Development Board, Department of Defense,—RDE-MS 200/2, 1 June 1951.

It was agreed that the administration of the plan would be vested in the National Research Council and $150,000 for support of the project was made available to the NRC in 1952 by the three medical services. Early in 1952 the National Academy of Sciences-National Research Council agreed to accept this responsibility and the contract was negotiated, the Army Medical Service representing the other Medical Services.

When the Medical Services began supporting this program in 1952 Chemical Corps support tapered off. The contract with the National Opinion Research Center, with NRC approval, was continued under Chemical Corps auspices but with funds transferred from the Medical Services. The contract with the University of Maryland has had NRC endorsement and has been funded by the Chemical Corps. The disaster phase of this contract has become of subordinate importance.

In fiscal year 1954 the Medical Services were forced to curtail their support of this project. However, its importance to national security has become recognized and its is likely that support from a national research foundation will enable the NAS-NRC to continue their activities in this field for another three years.

If the original objectives of the project are to be attained, the findings must reach the form of summarizing reports which include basic principles. These reports may take the form of books having scientific merit and of enough reader interest to warrant publication by a leading publisher. This phase is now in the embryonic stage but it is hoped that it will reach fruition within the next two years.

*This statement and that by Colonel Wood which follows is quoted from an unclassified report, "Conference on Field Studies of Reactions to Disasters" held at the University of Chicago, January 29-30, 1952. This report was issued by the National Opinion Research Center in January, 1953.

A FILTER FOR FINE AEROSOLS

By C. S. KEEVIL
Arthur D. Little, Inc., Cambridge, Mass.

Introduction

Filtration of fine particles from air is of great importance in both peace and war, for man is continually subject to the effects of suspended particles in the air that he breathes. Most airborne matter is in the size range of 0.2 to 1 micron, a micron being 1/1000th of a millimeter or 0.00004 inch. Nature has provided man with screening and absorbent surfaces in the nasal passages, but small particles may be carried deep into the lungs and there retained.

In industrial areas, aerosols are discharged into the air in the form of smoke and fumes. Where the terrain and meteorological conditions hinder the dispersion of the finely divided matter, aggravated conditions may occur such as the smog in the Los Angeles area. While the attack on this problem must emphasize the reduction in the discharge of finely divided matter into the air, filters have their place in protecting individuals and in purifying the air drawn into buildings by fans. Toxic substances may be used in war to produce aerosols having a lethal effect. With munitions, various types of aerosol clouds containing sufficient concentration of lethal material to cause casualties can be formed over considerable areas. Therefore, a layer of filter material to screen out particulate matter is an important component of a gas mask. The advent of the Atomic Age has sharply emphasized the need for highly efficient filters to prevent pollution of the air with radioactive particles, whose potentialities for damage are of a distinctly higher order than contaminants commonly encountered in the past.

The purpose of this article is to describe a highly efficient filter that makes it possible, on a large scale and at reasonable cost, to clean air to the point where it is almost entirely free of suspended matter. There are many types of air washers, electric precipitators, and wet and dry filters that will remove a high percentage of the total dust load in the air. They show a high efficiency for separation of particles from a micron upward, and occasionally for smaller particles of high density. On an overall mass basis they may show impressively high efficiencies in tests on dusts of mixed sizes. But they are quite ineffective for removing particles in the size range from 1 micron diameter down to 0.2 or 0.1 micron, as determined by the actual particle count before and after the filter. However, a nearly absolute cleaning of air is essential when highly toxic substances are present. To provide clean air for critical areas in hospitals, in laboratories, and in some industries, a degree of purification is required that is quite beyond the capacity of the commonly available devices. One of these, however, may well serve as a pre-filter for a final filter of the type described in this article.

The particulate matter that occurs in ordinary air and that is not removed by conventional air cleaning apparatus may be either liquid or solid. The concentration of such particles, in the size range from 0.2 to 1 micron, is of the order of 5 million to 30 million per cubic foot. While this number seems large, it represents only a very small fraction of the total volume. Thus, if a cubic foot of air were to contain 28 million particles each 1 micron in diameter, the total solids present would occupy only about one part in one billion of total volume. The filters described are so efficient that they remove all but a few hundredths of 1% of such particles from the air that has passed through them.

Historical

During the recent war, much work to improve filters for gas masks was done by the Chemical Warfare Service and by the National Defense Research Committee. Detailed accounts of these investigations, in which many people participated, have been written, and no attempt will be made here to identify individuals with particular achievements. Before the war, available filters were quite ineffective for the removal of particles having diameters of the order of a few microns. In 1941 it was shown that a mixture of cotton fibers and asbestos fibers, when dispersed in water, could produce a small "handsheet" of filter paper having superior properties. Attempts were then made to produce similar paper in quantity, using commercial papermaking equipment. These attempts were unsuccessful, for the existing equipment did not give an adequate dispersion of the fine asbestos fibers essential to the formation of a highly retentive sheet. Studies were then undertaken to evolve a process for separating fibers and incorporating them in a filter paper. At the same time, extensive work was done to determine which types of asbestos would give the best results. Good filter paper was produced, but the techniques necessary for adequate mechanical strength gave an undesirably high resistance to air-flow, especially when several layers of paper were employed in series as was considered necessary to ensure a high degree of protection. Finally a thin sheet of open structure was developed with a cheesecloth backing to give a high tensile strength. This sheet was so effective as a filter, while having low resistance to airflow, that fewer layers were necessary. Indeed a single layer was found to be sufficient in certain masks developed for the Army and Navy. Near the end of the war, experimental filters showing excellent performance were made from glass fibers and from superfine fibers of cellulose esters.

Soon after the end of the war, the operations of the Atomic Energy Commission gave rise to a need for highly efficient filters to prevent discharge of toxic radioactive particles into the atmosphere. The Chemical Corps provided filters incorporating the paper that had been developed during the war. Soon thereafter the AEC awarded a contract to Arthur D. Little, Inc., to work on the further development and improvement of filters. One objective was to develop filters that could be made from readily available domestic raw materials. Another objective was to develop filters that could withstand high op-

DR. CHARLES S. KEEVIL

Dr. Keevil was graduated in 1923 from M.I.T., where he also received his graduate training and was an instructor in Chemical Engineering. He later was head of the Chemical Engineering Department at Oregon State College, and at Bucknell University. During the war he was stationed at Edgewood Arsenal as the representative of Division 11 of the N.D.R.C., and in November 1945 he joined the staff of Arthur D. Little, Inc. He is secretary of the New England Chapter of the Armed Forces Chemical Association.

erating temperatures. The overall purpose of the work was to lay the foundation for practical and economical large-scale production of high-efficiency filter papers.

The Problem

An ideal filter medium must have a low resistance to the flow of air and should have the ability to retain particles of a wide range of sizes, trapping nearly all of them. It must have adequate mechanical strength, must be adaptable to incorporation into a practical device, and must be as compact as possible. These considerations suggest that a sheet of paper having suitable properties might well constitute an ideal filter medium. It must then be possible to produce the paper by use of commercial paper-making machinery and techniques, or practical modifications thereof. The necessary raw materials must be available in quantity, preferably from domestic sources and at a reasonable cost.

To be effective for the removal of fine particles from air, it appears that a dry filter must incorporate a large number of fine fibers with approximately the same diameters as the particles. Particles larger than 1 micron are likely to be carried against the fibers by inertia and caught. Those below 0.1 micron may be caused by Brownian movement to deposit on closely packed fibers. But particles of intermediate size may be carried around fibers by the moving stream of air in which they are suspended. Presumably as a result of this combination of factors, test data frequently show a maximum in the curve of penetration versus particle diameter. Particles that are about 3/10 micron in diameter appear to be most difficult to remove by filtering. After a study of many different fiber formulations, in hundreds of tests, it appears that the highest filtering efficiency is obtained when the filter medium contains the maximum number of fine fibers, present in a wide range of sizes, and uniformly distributed in an evenly dispersed unclotted formation with free air space between adjacent fibers.

A fundamental difficulty is that all mechanically strong papers have high resistance to the passage of air. The usual paper-making process involves hydration and swelling of the cellulose fiber and a subsequent cementing together of the fibers to form the sheet. This process imparts strength, but is very detrimental of porosity.

To obtain even moderate strength in a sheet that offers low resistance to the passage of air requires a special formulation and most careful handling in the paper mill. Moreover, cellulose fibers commonly run 10 to 30 microns in diameter and hence can serve only as the lattice or framework on which to suspend the finer fibers essential for the removal of small particles.

Figure 1. Detail of filter showing path of air

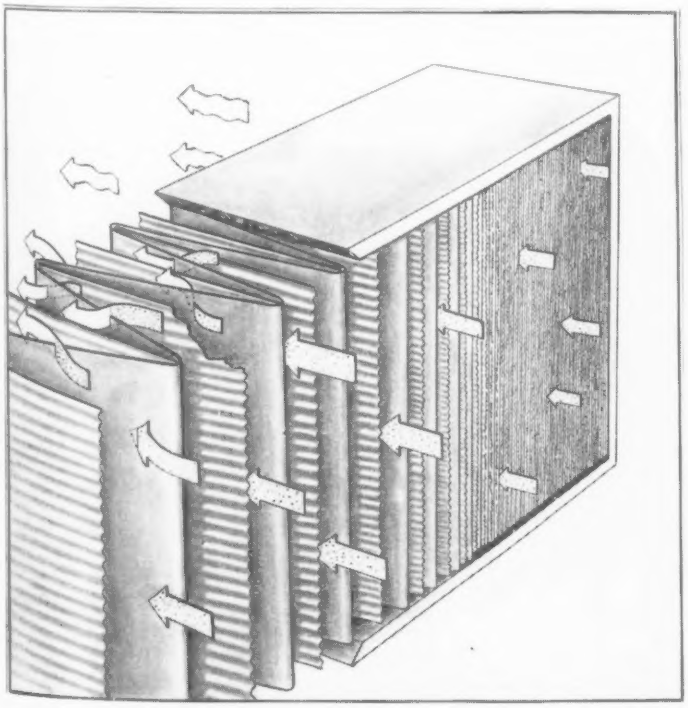
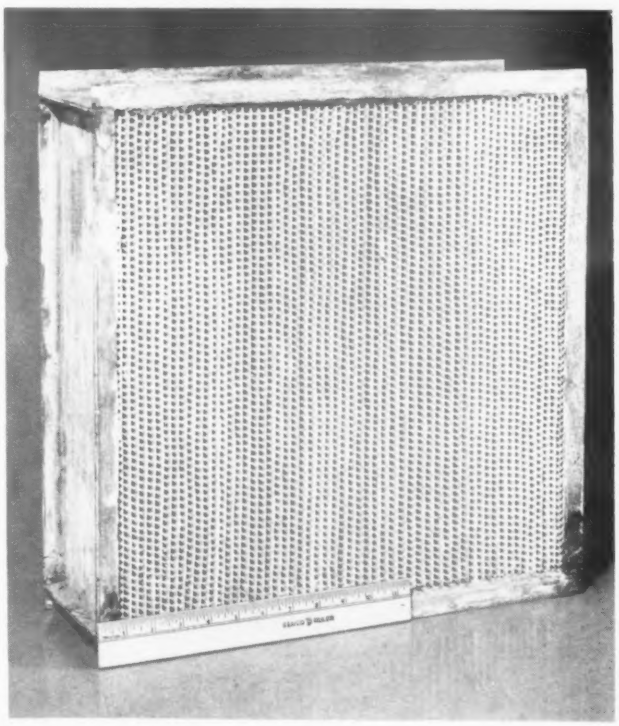


Figure 2. High-temperature filter



The Solution

The investigations leading to a successful paper have been carried on for a number of years, and have included laboratory study and many paper mill runs. Fibers of many different kinds were tested, singly and in combination, and with the addition of various resins, binders, and surface-active agents. Many of the early papers thus produced had some excellent properties, but none of them fulfilled all the requirements. In some instances it was found that promising results obtained with handsheets produced in the laboratory could not be duplicated in mill runs.

An important step toward a solution of the problem was the discovery that caustic treatment of a domestic kraft pulp would wrinkle the fibers so they would interlock to give a paper having adequate strength and an open structure. This material could then replace the imported cellulose fiber that had been employed in the Chemical Corps paper.

Of major importance was the discovery that certain types of asbestos, when combined with the cellulose, would yield a sheet meeting all basic requirements. These types are known as Blue Bolivian and Blue African asbestos. The asbestos must be separated into fibers in a range of sizes from 1 to 2 microns in diameter down to small fractions of a micron. When cut to short lengths, these fine fibers blend with the cellulose into a fine network free from clumps or voids, forming a sheet that will readily pass air and yet retain nearly all of the extremely fine suspended material, 99.95% or more by actual particle count. The desired combination of properties is obtained with a sheet consisting of about 85% paper pulp and 15% asbestos. Though many attempts have been made, it has not yet proven possible to substitute domestic asbestos for the imported types. For example, Chrysotile asbestos from Canada or Arizona breaks down into much finer filaments, but these fibers agglomerate and give a random uneven formation in the sheet with resultant lowered filtering efficiency.

In the course of experimental paper mill runs it was found that the production of satisfactory paper depended on many small points of technique in the formation of the sheet. By close attention to details of operation, filter paper of excellent quality is being produced with conventional paper-making machinery. The finished paper comes off in a continuous roll with a sheet thickness about 0.035 to 0.040 inch. It is soft and felt-like in appearance, resembling blotter paper, but strong enough to be folded and otherwise handled while being made up into filter units. Air will pass through this sheet at a linear velocity of some 4 to 5 feet per minute, with a pressure drop of 1 inch of water, and with nearly complete retention of fine air-borne particles as noted above.

Several tests may be used to evaluate the performance of these filter papers. One common test employs the smoke penetration meter. Air containing a carefully generated liquid smoke of uniform particle size of 0.3-micron diameter is passed through the samples, and the concentration of smoke is shown by a light-scattering technique.

Where a filter is to be used to remove dust normally found in air, it is more significant to test its performance on naturally occurring dust particles. This can be done by making a direct count of particles before and after the filter. Samples of dust are taken by a special device known as an impactor, in which the air is directed at high velocity against a coated slide where the dust particles collect and can be counted under a microscope. The effectiveness of these filters is shown by the fact that in one test a 10-second period of sampling by the impactor was sufficient ahead of the filter, while at the same flow rate for sampling beyond the filter a period of 16 hours was required to collect enough dust particles to count.

The Filter

In order to handle the volumes of air required in the practical application of these filters, it is necessary to work out an arrangement that will provide many square feet of filtering surface and that will ensure that the air will pass through the paper and nowhere else. This is done by folding the paper in a series of pleats spaced by corrugated separators to form a compact filter pack. The pack is cemented into a substantial wooden frame and then sealed at the edges with a suitable adhesive (Figure 1). The filter can be made in various sizes, one being 2 feet by 2 feet on its face and a foot thick. It contains approximately 60 folds of paper providing nearly 250 square feet of effective filtering surface. Figure 1 shows the path followed by the air. This filter has a throughput of 1000 cubic feet of air per minute at its rated capacity.

The frame can be fitted with gaskets and rigidly installed at the intake to a fan or in the duct through which the contaminated air passes. The performance of the filters will be as good as that of the paper itself, provided there are no leaks. All but 0.02% of the suspended fine particles are caught in the filter.

While these filters cost more to make and to operate than the less efficient common types, they do a job that the others won't do and hence should not be compared directly with them. For example, practically 100% of the fine dust caught by these filters will pass through the paper bag commonly used in a household vacuum cleaner, and perhaps half of it will pass through the glass fiber mat used in ordinary air cleaning filters. As much as 8% will pass through a half-inch layer of glass fiber mat composed of fibers having a diameter of 1.3 microns.

Because of their high content of cellulose fibers, these filters will not withstand continued exposure to extremely high humidity or water fog. Since they are readily combustible, they are easily disposable by burning; but they will burn readily in the air stream passing through them if accidentally ignited. They should usually be used in combination with a prefilter that will remove the major dust load and leave the high-efficiency filter to handle only the extremely small particles for which it is uniquely suited.

Filters for Higher Temptratures

The filters described above are intended for use at normal temperatures. Although brief exposures to 250°F can be tolerated, prolonged operation at 220°F or above will deteriorate the filter medium. There are many applications where filters that can withstand temperatures to 500°F or somewhat higher are needed. Such filters (Figure 2) are now being produced. They have a steel or aluminum frame, aluminum foil separators, and a filter sheet of all-mineral fiber. This consists of about 80% glass fibers of 3-micron diameter, the remainder being either the asbestos fiber used in low-temperature filters or fine glass fibers of ½-micron diameter. A small addition of synthetic resin acts as a binder and imparts sufficient strength to the sheet for handling and formation of the filter package.

The sheet is produced with commercial paper-making machinery. A great deal of care must be taken in the preparation of the stock to be fed to the machine. At every stage during the formation of the sheet, conditions must be carefully controlled to obtain a product having the desired properties. During a run, grab samples are taken off the machine and their filtering efficiency determined in a standard smoke tester. If needed, more asbestos slurry is run into the feed stock.

(Continued on page 37)

CURRENT ARMY PROCUREMENT POLICIES

From an address before the Cleveland Chapter of A.F.C.A., Feb. 12, 1954

By COL. WILLIAM H. GREENE
Chief Program Coordination Office
Office, Chief Chemical Officer,
Department of the Army

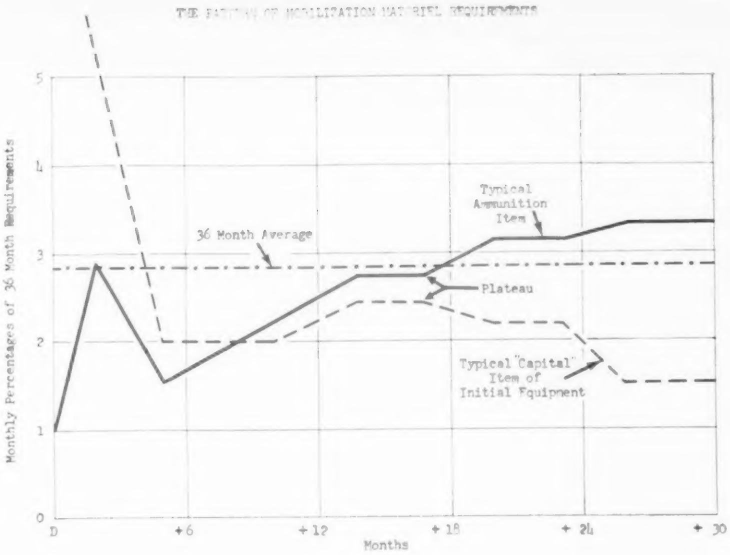


Fig. 1

Current Army Procurement Policies is a subject on which the Army needs the complete and sympathetic understanding of industry. I believe that industry has a right to know the general direction and objectives which the Army is following. The Army does not buy things helter-skelter during periods of expansion nor does it cut procurement at random during periods of economy. We have a basic logistic plan which can and must be adapted to most circumstances.

The first objective of the procurement plan is the satisfaction of current operating requirements. The existing Army must be fed, clothed, equipped and paid and the posts must be maintained.

The second objective is the accumulation of mobilization reserves. It is the general impression, I think, that the Army would like to place into storage for reserve everything it thinks it could conceivably need during a future war. This is far from being the case. It is the Army's advantage to keep mobilization reserve materiel down to a minimum. For one thing, materiel becomes obsolete all the time, and the less we keep in reserve, the less we have to replace as new developments occur. Second, the cost of storage space and of the care and preservation of large quantities of materiel in storage is a substantial drain on the Army's annual funds. Finally, a slow build-up of the mobilization reserve permits the production base for war materiel to continue in operation as long as possible, and a going production base is a much more valuable logistic asset than one that has been shut down or converted to civilian production.

Based on Mobilization Plan

Procurement planning for mobilization begins with the overall mobilization plan, and is developed to support that plan. Although the details are highly classified, enough of its broad outline can be revealed to show the principles upon which procurement planning is based.

It is a matter of common knowledge and national policy, for example, that the United States does not maintain a large standing Army, and does not intend to wage a "preventive" war. Therefore, in the event of an attack against us, we shall have to meet that attack with the forces on the spot, augmented as rapidly as possible by shipping troops from the continental United States to the threatened area or areas. Simultaneously, reserve and National Guard divisions would be called into Federal service, and new divisions would be formed and trained, and eventually these units would be shipped to the combat theaters. It is well-known from our World War II experience that training would take the better part of a year. So the first year of war would see a relatively small number of U. S. divisions in contact with the enemy, and a relatively large number in training.

During the second year, the ratios would slowly be reversed and by the latter part of the second year and thereafter, the great bulk of our troops would be in combat. Beyond the third year, the plan is purposely kept flexible.

The detailed timetable which will be followed, the number of divisions in the plan and the strategic employment contemplated are not only Top Secret, but very closely held in the upper planning echelons of the Army staff. However, the basic concept that the plan provides for roughly a year during which our forces are being raised and trained, followed by another year during which they are being moved into combat zones, followed thereafter by maximum commitment to combat is a matter of common knowledge, and will serve as a frame of reference for an understanding of logistic planning for such a mobilization.

It is basic to Army logistic planning that such planning follows the strategic plan, and exerts every effort to sustain it. The mobilization plan must be a plan that will win a war, and during the time between now and the day we are attacked, the logistic planners must plan to acquire the necessary logistical support. (A "capabilities" plan whose strategy is tailored to fit the available logistic support is kept up-to-date, but is regarded as an interim, or emergency, plan.)

Logistic support for any plan has many facets. It embraces the provision of clothing, food, shelter, medical care, communications, weapons, and ammunition. It is concerned not only with the initial issue of "capital" equipment, but with a system of re-supply. We are here concerned, however, only with items of military equipment such as tanks, weapons, ammunitions, radio sets, guided missiles, and we will eliminate from this discussion not only hospital, communications, and distribution systems, but "soft goods" as well. Normally, the soft goods industries can convert from civilian to military type production with so little delay, that planning in this area is relatively simple.

The Requirements Pattern

As the strategic plan is converted into detailed requirements by item, an interesting pattern emerges. (See

Fig. 1.) The requirements for some items are high during the first year of the plan because they are part of the initial issue, or capital equipment of the units being created and trained during that period. Examples are heavy howitzers, radio sets, or $2\frac{1}{2}$ ton trucks. Much of this equipment, however, is not ordinarily subject to heavy loss in combat and is not consumed by combat, so that a chart of the month-by-month requirements of such an item would show a large requirement during the first year of war—from D-Day, the day that war begins, to D plus 12 months—then a leveling off during the next year while the chain of warehouses and depots between the factory and the combat zone (known as the "pipeline") was being stocked, and finally a tapering off of requirements down to the level required to replace combat losses. Almost the reverse is true of the ammunition type of item. During the first year of war, ammunition requirements are relatively small because there are few units in combat, and the new units require only sufficient ammunition for target practice and other training. Then requirements step up as the pipeline is filled and as units move into combat. By the latter part of the second year and thereafter, ammunition requirements are high and increasing. A third type of item partakes of the nature of both these others, for example, the medium tank. It is required as an item of initial issue for newly activated units. But as units enter combat, tank losses are almost as directly proportional to combat time as is ammunition, and on a graph of requirements the line for tanks is almost straight across from D-Day to D plus 36.

A second interesting fact is that because of the basic structure of the war plan, as outlined above, the requirements curves of all items show a plateau during the period of D plus 12 to D plus 18 months, i.e., during the first half of the second year of the plan. And because the high requirement during initial equipment of our units, or the high rate of expenditure during combat, makes most of these curves lopsided, the D + 12 to D + 18 plateau is lower than an *average* across the board. In terms of best utilization of available funds and resources, therefore, it is more economical to calculate item by item the D + 12 to D + 18 plateau than to take a monthly average of the total requirements.

Lead Time Considerations

The next step in procurement planning is to relate the requirements curves to production capabilities. One of the facts of life in this area is the lead time required to produce military items. The elimination of soft goods still leaves us with a serious planning task for those items with a substantial lead time.

Since increased production cannot be achieved until the lead time has elapsed, what about requirements for military equipment in the meantime? That is, during the period from D-Day to P-Day (the day, for each item, when monthly production equals monthly requirements) what can be done to provide requirements for initial issue, for training, or for combat? The quantity required during this period is known as the Mobilization Materiel Requirement, and it can come from only two sources: stocks on hand produced before D-Day, or from production lines in operation during the period of build-up to all-out production. The figure for the stocks required to be on hand on D-Day is known as the Mobilization *Reserve* Materiel Requirement, or MRMR, and is a quantity which varies with the number of the production lines in operation after D-Day.

It is this production capacity, whether operating, in standby, or in reserve—the mobilization base or production base, as it is variously called—that forms the basis of production planning for mobilization. As long as the fully prepared portion of such a base can be kept turning over at a slow rate, it is producing items for the MRMR, it is supplying current peacetime requirements, and it can make the necessary modifications from time to time to prevent the items in production from becoming obsolete. It also reduces the size of the MRMR required because its post-D-Day operation will fill part of the post-D-Day requirements, and because a going line can accelerate to around-the-clock operation more rapidly than a line that is down. In logistics planning, therefore, maximum reliance is placed on an operating production base rather than in stocks on hand.

Types of Production Readiness

Obviously, the most desirable situation is that wherein D-Day finds the country with production lines turning over and actually producing necessary end items. If these lines are running at one shift, experience shows that by going to three shifts, even with the admitted disadvantages of the third shift, or to two ten-hour shifts, we can secure about $2\frac{1}{2}$ times the production of a single eight-hour shift. For planning purposes, therefore, it would be desirable to have sufficient lines in operation so that when their D-Day production rate was multiplied by $2\frac{1}{2}$, the increased rate would equal the D + 12 to D + 18 plateau rate. This production rate could not be achieved immediately, of course, because it would be necessary to increase the production of raw materials and of component parts produced by subcontractors. Except for a few longer lead time items, the twelve month period is ample time for operating producers to attain the increased rate.

A special situation is presented by those industries like the chemical industry which normally have continuous batch processes which cannot be operated in shifts or at reduced rate. This situation must be taken into consideration in almost every type of planning. In ammunition, for example, the metal parts are produced on a shift basis, while the propellants and explosives are produced by continuous batch processes.

Next to having lines in actual operation, the best situation is having lines in "standby" status. In government-owned plants and arsenals, it is possible to have the production equipment actually installed in lines, and receiving sufficient maintenance to prevent deterioration. Obviously such lines can be placed in operation very quickly and which reduces the time required to achieve production.

A third status exists where the necessary tools and equipment are placed in reserve. Upon mobilization, space must be found, labor must be available or readily trained, and then the production equipment needed for military items can be removed from reserve and placed in operation. This situation, while giving a slower build-up than lines in actual operation or in standby, is still faster than waiting for delivery of machine tools which have a lead time of nearly 18 months.

It is important to note, however, that although we have caluculated our production base to equal a less-than-average plateau, and although we have taken into account post-D-Day production, there still remains a quantity that must be on hand when D-Day comes to permit the implementation of a war plan that will win the war. There is not enough storage space in the United States to permit the accumulation of enough materiel to meet the total requirements for three years of the war plan or even for two years of such a plan. Yet after all allowances are made for expected production, there still remains an irreducible minimum—which is a major por-

tion of the first year of war requirements—which must be on hand on D-Day if we are to fight according to plan.

I have gone into this much detail on the logistic support of the mobilization plan to show that the Army has approached its planning task as conservatively as possible so as to live within its means.

Maintaining Mobilization Base

The third objective of the Army's procurement policies is the maintenance of the mobilization base described above. It is essential that we place current and mobilization requirements and the requirements of our other customers so as to keep this base in operation—at a slow rate if need be—as long as possible. It costs money, and procurement money at that, to retain and maintain the production base in a standby status.

Our fourth objective is to satisfy the requirements of the Army's other customers—the Navy, the Air Force, and our overseas Allies. It is not generally recognized that since the outbreak of the Korean action, nearly 30 percent of the Army's procurement job is performed for these other customers. By interservice agreement, or by direction of the Department of Defense, the major categories of supplies have been allocated to one service or another for single-service procurement. Thus, the Army procures lumber, tractors, motor vehicles, subsistence, weapons and ammunition, (except for specified Naval gun and shells) etc. For such items, the Army must procure what is requested but has no primary responsibility for *planning* current or mobilization quantities or for maintaining a mobilization base. There are some few cases where the Army has obtained the funds for a production base for the other services and has planned accordingly.

The current drive for economy affects the entire procurement plan. Current requirements are being closely scrutinized. There are many savings—each one possibly small in itself—which can add up to large figures in the aggregate. One of the major savings currently being made in the procurement field is a tighter control over stocks of spare parts and other items of current consumption in Army depots. Previous directives set up general policies which tended to be interpreted for the convenience of the operating personnel and which resulted in the acquisition of excess quantities of many items. Present directives place a very firm limit on the quantities to be accumulated and no new procurement is permitted until present stocks are reduced to these limits. Any really major reduction in current requirements can only be achieved by a reduction in the number of active divisions, but this will be achieved slowly. The apparent cessation of hostilities in Korea may permit the ultimate release of some of our present divisions.

The "Floating D-Day" Concept

As to the concept of no fixed D-Day, which is known as the "floating D-Day" concept, that presents a certain number of theoretical difficulties, but in practice is permitting substantial reductions in procurement. The Army plans to attain in the fairly near future a large portion of its mobilization requirements of weapons and ammunition, but to defer all but a small portion of such classes of items as materials handling equipment and general purpose vehicles. The percentage of mobilization requirements to be procured has been evolved for each class of items by considering such factors as its essentiality for combat or combat support, the likelihood of early obsolescence, its similarity to regularly produced commercial items, and its stability in storage.

Further economies are being achieved by carefully examining the composition of the mobilization base for each major and critical item, and by keeping in production only the minimum number of facilities. As the quantities produced approach the total reserve requirement, the number of facilities in operation is progressively reduced.

The method by which these economies are effected is also interesting. Under ordinary conditions, procurement money must be obligated by the execution of contracts within the same fiscal year as that in which Congress appropriated it. However, since deliveries under these contracts cannot always take place within the year in which the contract is signed, two additional years are available for deliveries. The contractor receives his check sometime after delivery, and the check when cashed becomes a withdrawal from the Treasury of the United States.

During the Korean action, however, procurement funds that were not obligated during the fiscal year in which appropriated continued to be available for obligation in subsequent years by special Congressional action. Hence, we are now spending for procurement funds originally appropriated in FY 52, 53 and 54. Since the budget cannot be balanced without balancing Treasury receipts against Treasury withdrawals, the present policy is to control *expenditures* rather than new appropriations. This has involved reopening negotiations with many of our present contractors with the aim of protracting deliveries under present contracts or of terminating these contracts completely.

FILTER

(Continued from page 34)

Apart from their ability to withstand the higher temperatures, these filters are comparable to those previously described. Their efficiency improves after a period of about one hour's operation at 500°F. It appears that the resin oxidizes and the fibers adjust themselves to an optimum position. Test data show an appreciable reduction in the number of particles that will penetrate the filter after this initial period. The efficiency remains very high and, indeed, continues to improve with use until the build-up of accumulated material increases the pressure drop to the point where replacement is needed.

* * * *

Many applications of the high-efficiency filters have already been made to critical areas in hospitals and research laboratories, in the manufacture of optical instruments and photographic film, in the pharmaceutical industry, in the chemical process industries, and for the protection of fine mechanisms during manufacture and use. They are widely used at AEC installations to prevent discharge of radioactive particles, and might find application in the ventilating air intakes of public shelters and in individual protective masks used for civil defense.

The successful development of these filters is another one of the many beneficial results from research begun in connection with the war effort. While less spectacular than some developments, these filters are already proving to be of great importance. They will find ever-increasing application as the need increases to guard health and to furnish protection from contimation by the invisible particles floating in the ocean of air that surrounds us.

CHEMISTRY FLIES

(Continued from page 24)

aircraft, radomes, canopies, aircraft windows, wing tips, parts for optical systems, heat and electrical insulators, housings and others too many to mention. The following discussion of reinforced plastics at elevated temperatures will serve to illustrate the types of plastics applications and problems encountered in the Air Force.

Although, reinforced plastics were initially used in aircraft where electrical requirements did not permit the use of metallic materials, they are now used in their own right, ofttimes to replace metal components. Advancement in the development of piloted aircraft and missiles will be dependent to a significant degree on the satisfactory development of structural plastics to meet severe service requirements. Since one of the most difficult problems confronting the designer results from aerodynamic heating of plastic materials, the Air Force is investigating laminating resins with high strength properties and rain erosion resistant coatings at elevated temperatures.

Experimental resins have been developed which have vastly improved the properties of glass fabric base laminates at elevated temperatures. Typical resins include polyesters, phenolics, silicones, triallyl cyanurate, and the epoxides, and various co-polymers. The polyesters (alkyd structure) are one of the most promising easily fabricated heat resistant resins which have been investigated.

Since triallyl cyanurate was known to be outstanding as a heat resistant monomer, research in this area has been directed toward defining the reasons for its superiority. To date, this effort has lead to no conclusions but was productive in that several new resin systems suitable at elevated temperatures were discovered. Moreover the use of one of several new monomers studied, diallyl 4-3, 6-methanotetrahydrophthalate, in a mixed monomer system with triallyl cyanurate, revealed a synergistic monomer effect which has resulted in the realization of a substantial improvement in heat resistance as compared to straight triallyl cyanurate resins. The full potentials of this new system have not been realized in the relatively short time it has been known and further study is in progress.

The epoxide resins have exhibited extremely high mechanical properties at normal temperatures and work is in progress to develop improved high temperatures properties. Epoxide laminates are exceptionally strong in flexure and compression at room temperature and retain a satisfactory percentage of strength after soaking in water for 30 days, but they are relatively weak at 300°F and higher temperatures. One of the early steps in the investigation to improve the elevated temperature strength properties was to utilize previously known curing agents (notably dicyandiamide) and commercially available epoxide resins. The approach here was to postcure, to vary the concentration of the curing agent and to experiment with methods of incorporating the curing agent with the resin. It became apparent that existing commercial materials were not capable of yielding satisfactory elevated temperature strength. Another approach was the use of new, experimental epoxide resins which could be expected to have better heat resistance because of their particular chemical structure. Several such resins have been investigated and show promise of good resistance to long-time aging at 500°F. The search for new curing agents has yielded one which has substantially improved the 300°F strength of laminates made with commercially available epoxide resins (liquids), but to date no way has been found to utilize it with the newly developed, more heat resistant epoxide resins, which are solids, at low laminating pressures. Most of the work has been devoted to the modification of epoxide resins with phenolic resins, largely because some of these modifications have encouraging short-time elevated temperature strength. Several problems related to the presence of water of condensation from the phenolic resin were encountered and remain to be solved.

Since 1945, the Air Force has been actively engaged in the problem of rain erosion on exterior plastic parts. To date, the most satisfactory solution to this problem has been the use of protective coatings. These coatings must resist rain erosion caused by the high speed impact of water drops and must have minimum interference with the transmission of radar or other electrical signals. These coatings must not permit a high static charge buildup on their surfaces. At the present time, the most satisfactory coatings are the neoprenes. However, supersonic speeds will result in higher temperatures for outer surfaces of aircraft and missiles. Also, the practice of passing hot gases through specially constructed radomes for the prevention of ice formation on the outer surfaces may subject the protective coatings to elevated temperatures. The current neoprene coatings will not withstand temperature exceeding 350°F for any length of time. Work has, therefore, been undertaken to find materials, elastomeric and plastic in nature, which will meet the erosion resistance and signal transmission requirements and also withstand a temperature of 500°F for extended periods of time. A program has been underway in which various materials have been studied for possible application to solving the problem. To date, the lactoprene materials have looked the most promising. Strong, resilient compounds of lactoprene have been developed which age well at elevated temperatures as high as 500°F. Although the lactoprenes, originally, had poor water resistance and not sufficient resilience for successful rain erosion coatings, the addition of tributoxy ethyl phosphate and an ethylene glycol ester of fatty acid overcame these shortcomings. The erosion resistance of lactoprene compounds, though not as great as present neoprene coatings, does show promise. It is believed that erosion resistance could be greatly increased if curing of the lactoprenes could be improved. The effect of solvents and compounding materials on the cure is presently being studied. Under this program, silicones, teflon, and other promising materials are now being investigated.

The Air Force is sponsoring development to improve not only the heat and rain erosion resistance of plastic structures and surfaces as described above, but also other general properties of structural plastics and coatings. New resins, improved reinforcing materials, better lamination methods, new fabrication and finishing techniques and new structural arrangements all point toward an increased use of improved plastics and items.

Because of the rapid strides of our plastics industry toward improved fabrication methods, it is important to consider the role of reinforced plastics from the viewpoint of production planning. From such a production capability perspective, it appears that, where plastics applications have proven satisfactory, the use of reinforced plastics can save lead time, production time and oftimes money. Plastics offer extreme versatility for making frequently-changed structural designs at low cost. A plastics make-up of an equivalent metal assembly, where feasible, presents an opportunity to reduce tooling problems, machining operations, critical metals scrap, the number of parts, end item maintenance, and over-all weight. Al these advantages are especially significant

in terms of industrial preparedness. From this point of view alone, plastics appear to have a special appeal for Air Force applications, even though in their own right they are the answer to many materials problems.

Because of the potential impact of the use of plastics on military aircraft in the New Air Age, the Air Force is looking to all segments of the plastics industry for developments which will contribute to improved aircraft design and facilitated production.

Aero Electronics

Little did the Wright Brothers contemplate an approach to the "New Air Age" in which their crude dream would, in fifty short years, grow to today's giants which reach fantastic heights and speeds. By the same token, we today are just beginning to realize the tremendous possibilities of the immediate future. Today's aircraft have reached the point at which man can no longer control his invention with his brains and hands. To fill the void man has, in turn, reconverted these "Mr. Jekyls" to "Dr. Hydes" by the application of electronics—those intriguing gadgets that do virtually everything but think. They introduce, however, a new cycle of growing pains. Although small quantities of a great number of substances are used in electronics, the development of transistors, printed circuits, and nuclear batteries will serve to illustrate some of the more dramatic advances which are precipitating new and progressive developments in the chemicals field.

The transistor is light in weight, low power consuming, and is expected to prove to be an extremely reliable unit, that in certain instances, can replace the vacuum tube in electronic equipment. When reliable transistors become available in quantity, it has been estimated that they will be able to replace approximately 50% of present vacuum tube usage. They are constructed of germanium or silicon crystals to which controlled impurities on the order of one part impurity per one-hundred-million parts of germanium or silicon are added during the growth of single crystals. To produce synthetically single crystals of this magnitude of purity, germanium dioxide containing 100 parts per million of impurities is first produced. This is reduced chemically to the metal, which, by means of repeated "zone purification" or gradient crystallization is brought to a "super-purity." Measured amounts of impurities are then added to this pure metal to make the required crystal structure. Because of the higher temperature resistance of silicon, the chemical industry is presently busily engaged in the development of processes suitable for the production of similar purity silicon.

Printed circuitry is an excellent example of an electronic development made possible through the combined efforts of the chemist and the electronic engineer. Printed circuitry involves a chemical etching process on a metallic overlay on a plastic plate. By this means, a circuit pattern can be inscribed on the base plate. These printed circuits, along with automatic placement of components by machinery, dip soldering processes, and final assembly of these units on stamped frames, are making possible mass production techniques in the assembly of electronic equipments. The resulting lower production costs, greater dependability, better adaptation to miniaturization and the increased ease of maintenance, all contribute substantially to the availability of military goods.

The nuclear battery, only recently announced to the public, is a device that converts nuclear energy directly to electrical energy. The cell consists of a strontium 90 source, an aluminum collector and a separating medium which may be either a gas or a plastic. The utility of these batteries depends upon long life and isolation from adverse environmental conditions. These contributions have been made possible through the efforts of the nuclear chemist.

In the development of improved performance in electronic equipment the research chemist, the electronic engineer and the physicist are continually working hand in hand to achieve an important common goal—increased reliability and miniaturization. The obvious importance to the Air Force mission of the need for constant improvement of these characteristics cannot be overstressed.

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The perspective of this article would not be complete perhaps without mention of special fuels and high energy chemicals as propellants for aircraft propulsion systems, assist take-off units, guided missiles, missile boosters and high velocity aircraft armament rockets. Other well-known uses for high energy chemicals are in high explosives, incendiaries and pyrotechnique illuminants. The development of new chemical processes must not be overlooked for their important role in the production of titanium, aviation gasoline, the above mentioned high energy fuels and oxidizers, critical chemicals, synthetic lubricants, synthetic hydraulic fluids, critical metals from scrap, and biologicals. Nor must we overlook the importance of special fabrication techniques such as shell molding which permits the mass production of precision parts and components for aircraft, and inert gas welding which permits a more versatile utilization of titanium, an essential material for supersonic flight. Protective coatings and other corrosion protective systems also have their place in the sun, for they provide the means of maintaining the efficient high performance of our modern aircraft.

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